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WAR DEPARTMENT

TECHNICAL MANUAL

MECHANICAL SMOKE GENERATOR M1 (100-GALLON)

May 12, 1943

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TECHNICAL MANUAL)
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MECHANICAL SMOKE GENERATOR, M1

(100-GALLON)

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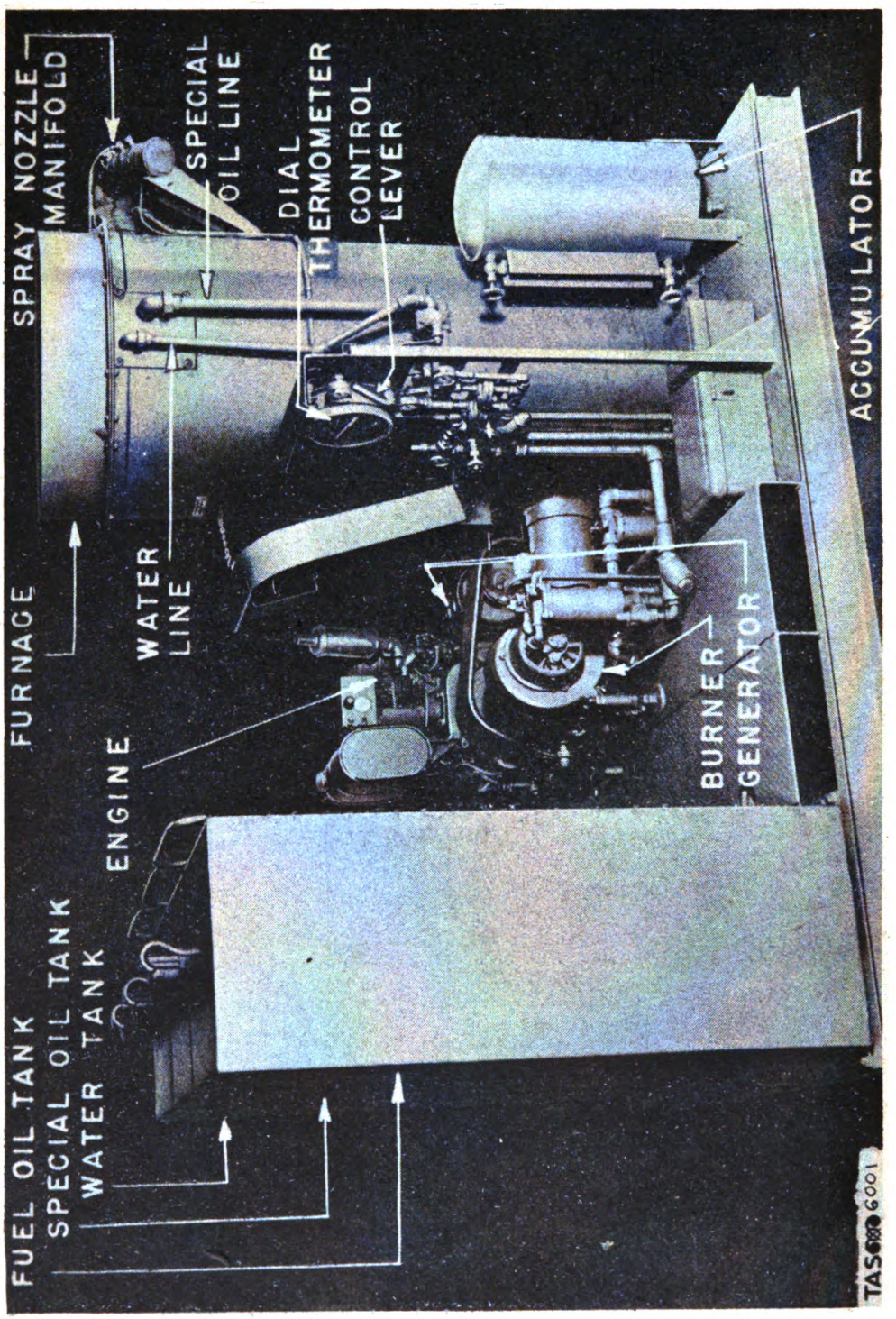

Fig. 1. The Mechanical Smoke Generator, M1 (100-Gallon).

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SECTION I

GENERAL

Paragraph

Purpose and scope 1
Purpose and use of generator 2
Difference among models. 3

1. PURPOSE AND SCOPE. This manual describes the mechanical smoke generator, M1, (100-gallon), its operation, maintenance, and repair by using personnel or by the smoke generator company. (See fig. 1.)

2. PURPOSE AND USE OF GENERATOR. a. Purpose. The generator is designed to throw into the air a dense streamer of white smoke. (See fig. 2.)

b. Use. In smoke operations a line of generators is used. (See fig. 3.) Downwind from the line of generators the streamers of smoke merge, forming a smoke cloud, or blanket. (See fig. 4.) The purpose of the smoke cloud or blanket is twofold:

(1) To prevent aimed bombing of the ground target by enemy aircraft.

(2) To hide the ground target from aerial observation.

3. DIFFERENCE AMONG MODELS. a. Burner mixture ignition. Of the mechanical smoke generators in use by the Chemical Warfare Service at this writing, some are magneto-ignition units. On these the spark between two electrodes which ignites the fuel oil-air mixture in the firebox is generated by current from a magneto belted to the engine take-off shaft and

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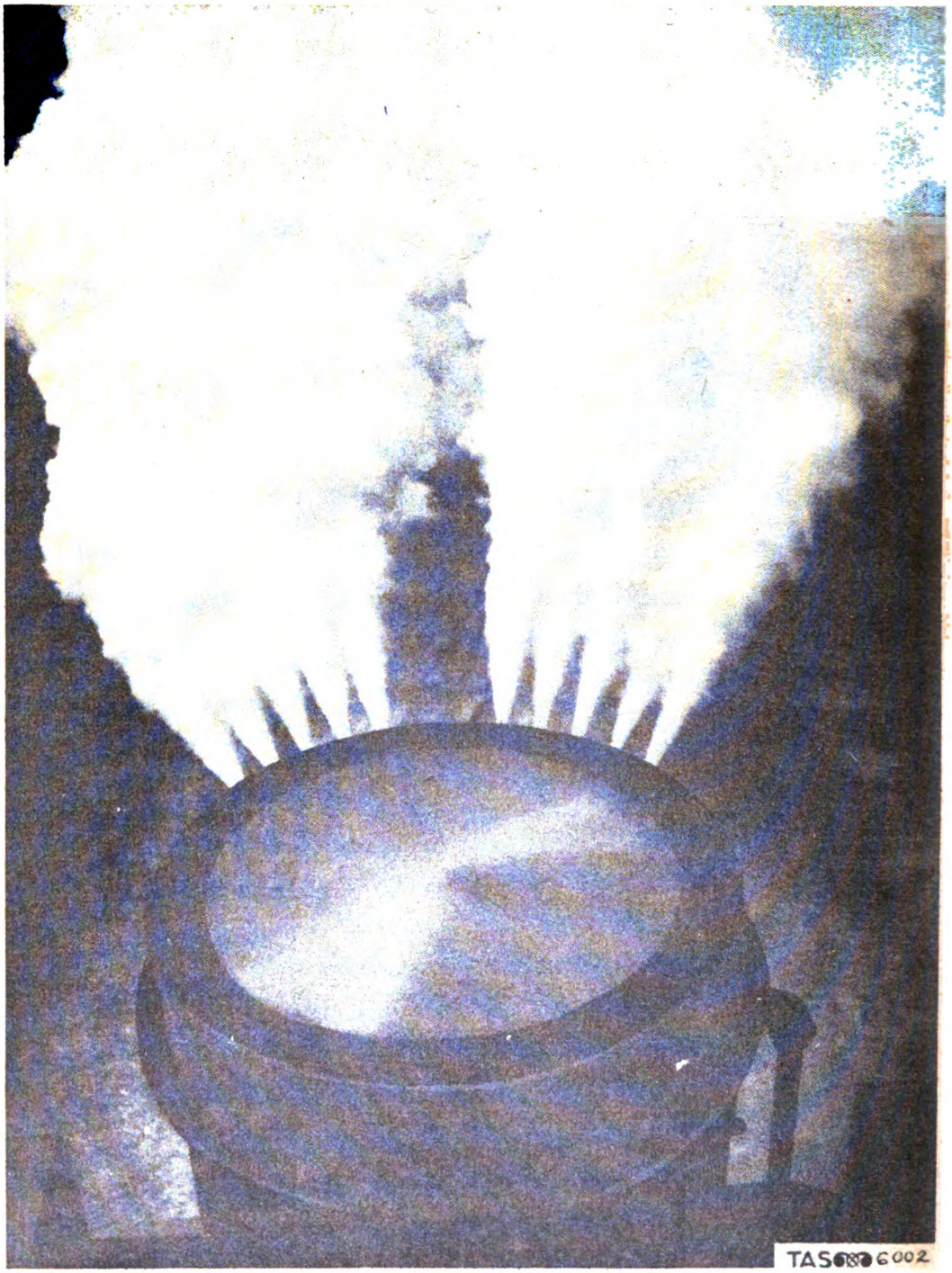

Fig. 2. Generator Making Smoke.

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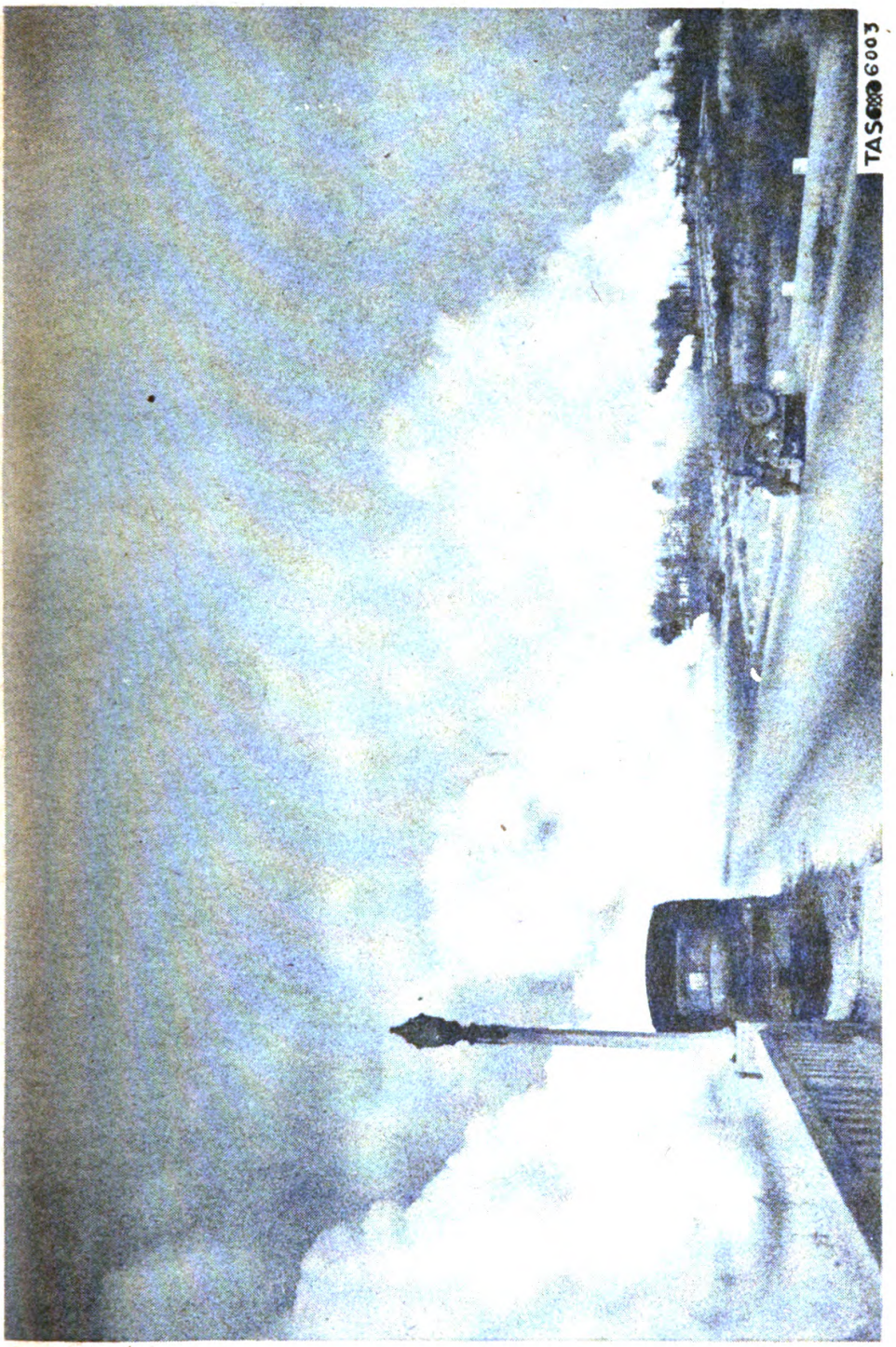

Fig. 3. Line of Generators Making Smoke.

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Fig. 4. Generator-produced Smoke Blanket.

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nown as the burner magneto. (See fig. 5.) All other mechan-cal smoke generators are transformer-ignition units, on each f which the spark is generated by a high tension transformer nergized by a 110-volt alternating current generator belted to he engine take-off shaft. (See fig. 6.)

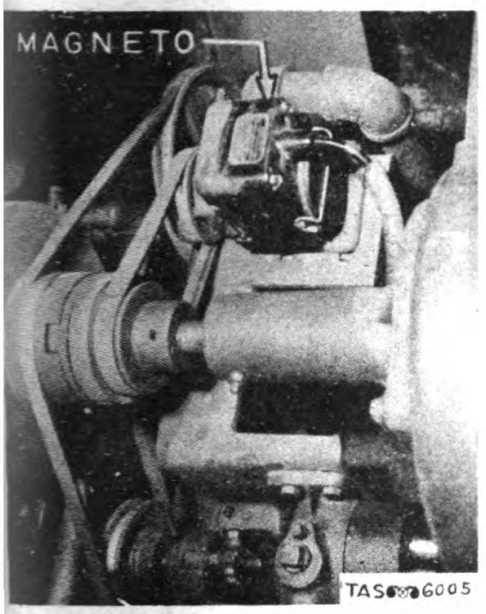

Fig. 5. Burner Magneto on Magneto-ignition Model.

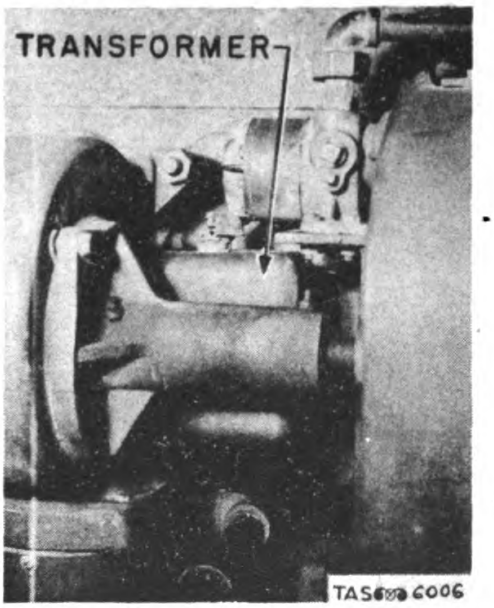

Fig. 6. Transformer on Transformer-ignition Model

b. Special oil suction line strainers. The special oil suction lines of the early models are equipped with a basket-type screen strainer. On the suction lines of other units, self-cleaning strainers are used. The differences between the two are described in paragraph 6.

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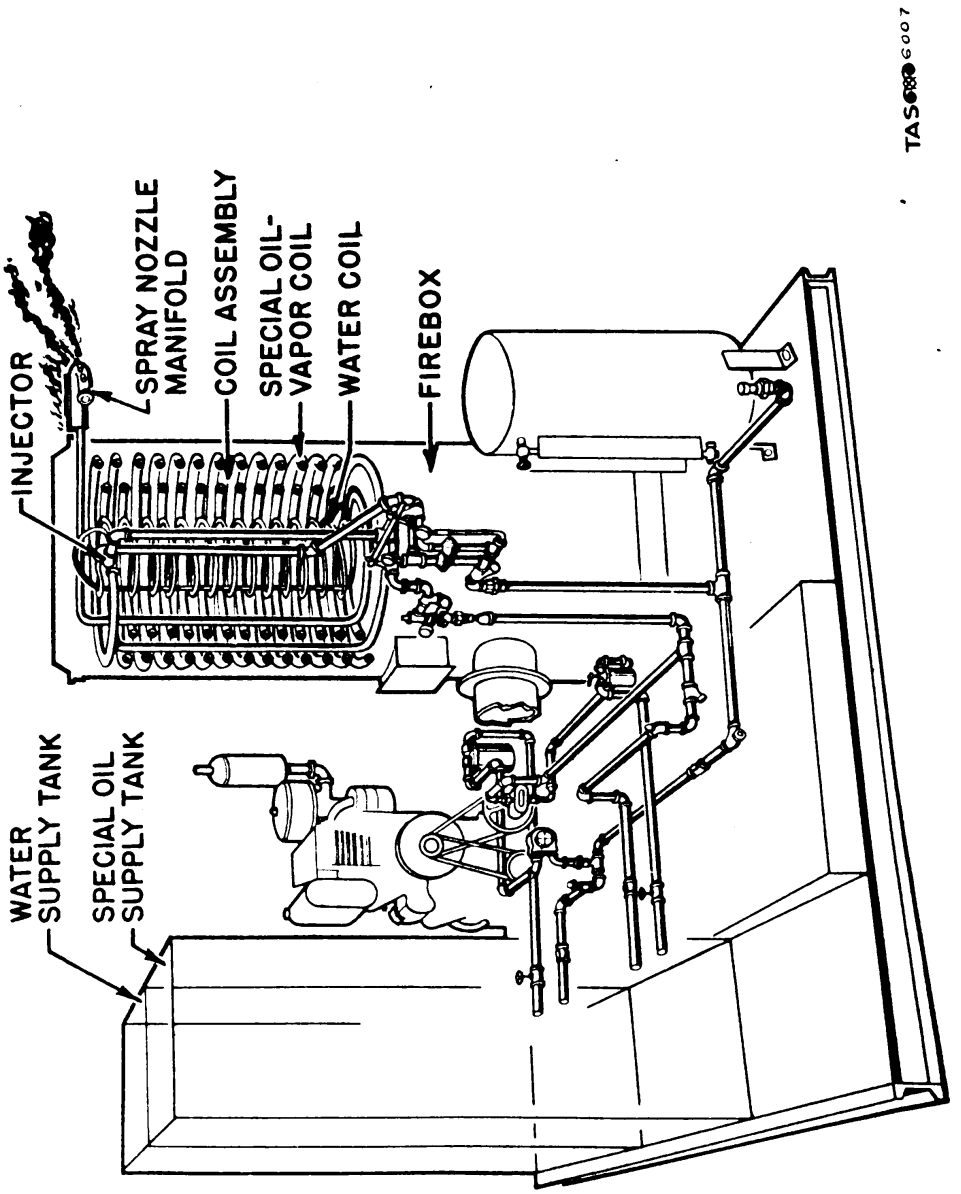

Fig. 7. Principal Devices Involved in Making Smoke

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SECTION II

DESCRIPTION

	Paragraph
How the generator makes smoke	4
The generator as a whole	5
Special oil system	6
Water system	7
Fuel oil system	8
Heating system	9
Control system	10
Accessories	11

4. HOW THE GENERATOR MAKES SMOKE. (See fig. 7.) The mechanical smoke generator produces smoke as follows:

a. Special oil is pumped from a supply tank on the rear of the generator to the injector of the coil assembly inside the furnace. The special oil arrives in the injector cold.

b. Water is pumped from another supply tank into the water coil in the furnace. As it flows through the water coil the water is heated by a burning fuel oil and air mixture in the firebox at the base of the furnace. The heat converts the water into vapor.

c. Meeting the cold stream of special oil at the injector, the vapor disperses finely throughout the incoming oil.

d. This special oil-vapor mixture now flows through the special oil-vapor coil and is super-heated as it does so by the flames in the firebox below.

e. From the coil the super-heated special oil-vapor mixture escapes into the air through ten 3/16-inch holes along

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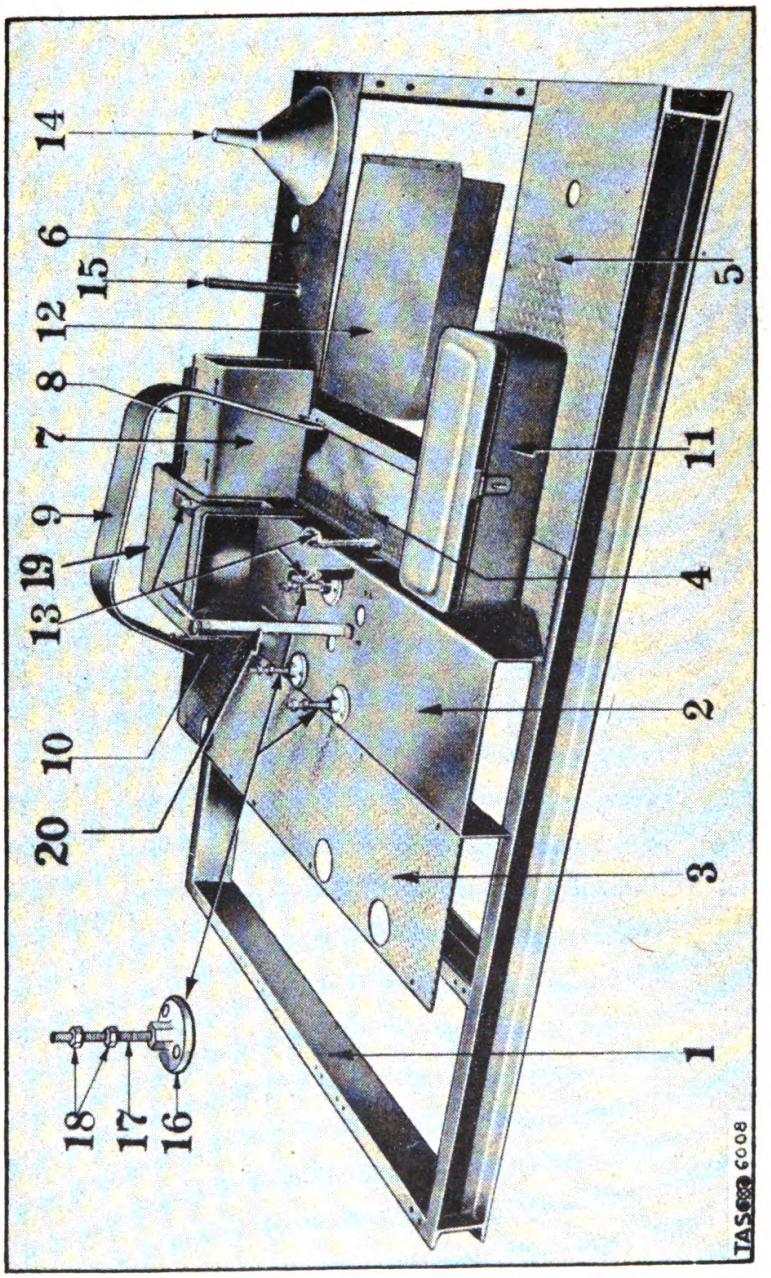

Fig. 8. Frame.

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1. Frame.
2. Equipment frame.
3, 4, 5, and 6. Floorplates.
7. Generator bracket.
8. Battery box.
9. Belt guard.
10. Belt guard bracket.
11. Tool box.
12. Burner cover.
13. Pipe clamps.
14. Funnel.
15. Funnel support.
16. Burner base.
17. Burner leg.
18. Nut.
19. Equipment frame platform.
20. Equipment frame bracket.

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the spray nozzle manifold.

f. In the air rapid chilling causes the mixture to condense, thus forming a maze of tiny liquid droplets. This maze is the smoke.

5. THE GENERATOR AS A WHOLE. a. Weight. The mechanical smoke generator weighs approximately 3,000 pounds empty, approximately 5,400 pounds when filled with liquids.

b. Frame. (1) It is mounted on a 5-foot, 6-inch x 6-foot frame in order that it can be carried on a trailer, barge, truck, or other vehicle, or placed on the ground or on pilings in the case of offshore installations.

(2) The components of the frame are shown in figure 8. The equipment frame platform serves as a base for the engine, the latter being bolted to it. On the transformer-ignition models the generator bracket supports the ac-dc engine generator, the latter being bolted to it. On magneto-ignition generators, the battery-charging dc engine generator is bolted directly to the engine. The pipe clamp nearest the equipment frame platform helps support the water piping; the other two clamps help support the special oil piping. To the equipment frame bracket are bolted the special oil and water pumps, and on the magneto-ignition models the burner magneto also is bolted to this bracket. As its name implies, the burner cover serves to protect the fuel oil burner when the unit is not in operation. On the assembled generator it is hinged to a bracket extending from the furnace at a point just above the burner. All other parts of the frame are self-explanatory.

c. Parts. The major parts of the generator are:

(1) Special oil system.

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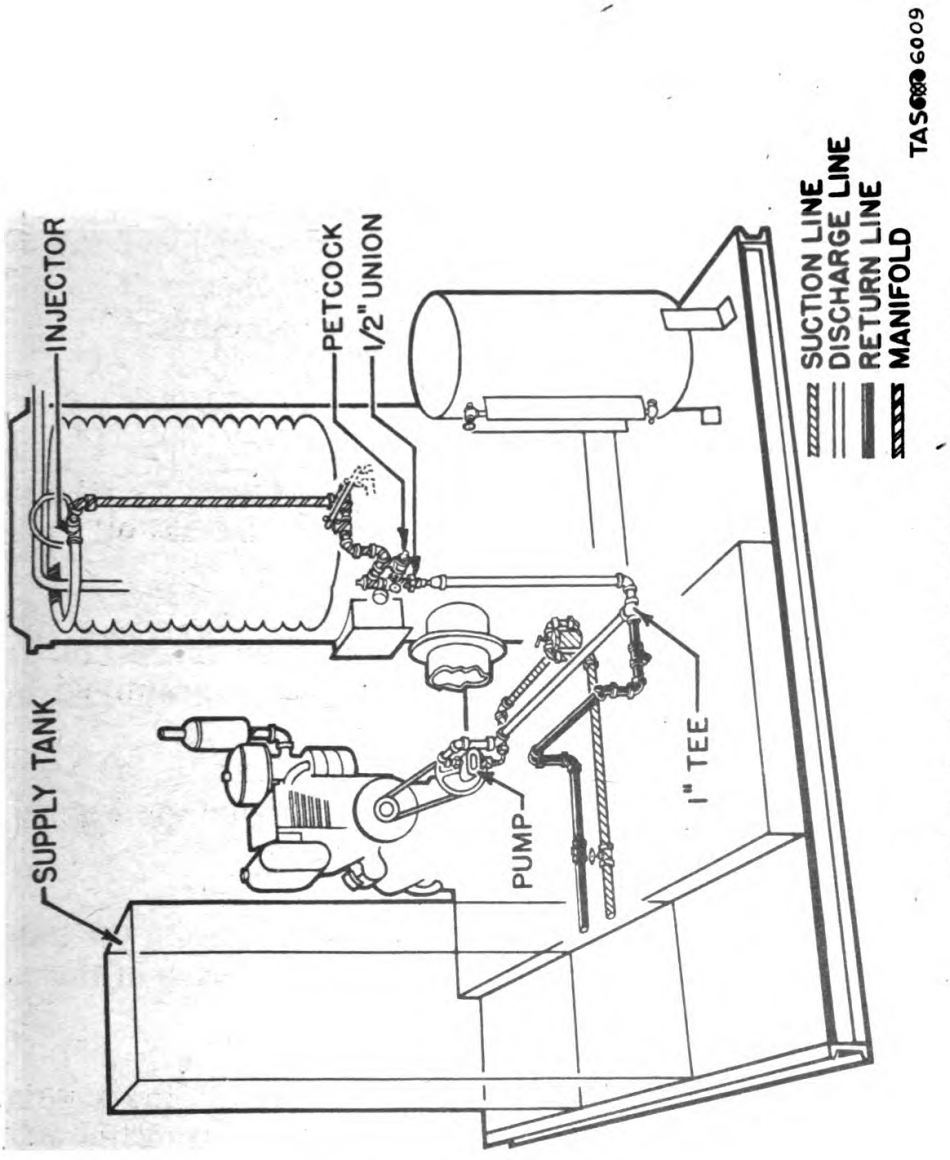

Fig. 9. Special Oil System Piping.

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(2) Water system.

(3) Fuel oil system

(4) Heating system.

(5) Control system.

A description of these parts and how they work together to produce a streamer of smoke will be found in paragraphs 6, 7, 8, 9, and 10 following. The description of each part is accompanied by a photograph showing the components of the part in the order in which these components go together.

6. SPECIAL OIL SYSTEM. a. Definition. The special oil system consists of all piping and devices directly involved in making possible and controlling the flow of special oil from the special oil supply tank to the coil assembly.

b. Piping. The piping which carries special oil from the special oil supply tank to the injector is diagrammed in figure 9. It consists of four main sections:

(1) Suction line. This extends from the supply tank to the special oil pump.

(2) Discharge line. This extends from the pump to a 1/2-inch union (as shown in figure 9) at the base of the manifold.

(3) Manifold. This name is given to the special oil piping between the union at the end of the discharge line and the injector. On the manifold is a petcock through which special oil may be released in the event of such emergencies as the accumulation of air pockets in the system.

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(4) Return line. This extends, as shown in figure 9, from a 1-inch tee on the discharge line back to the supply tank.

c. Flow. Taking suction from the supply tank, the pump draws the special oil through the suction line. It then discharges the oil into the discharge line, from whence it flows into the manifold. Toward the termination of the manifold is a quick-opening valve. (See fig. 10.) During the start of operations, and while the smoke generator is being operated in the "start-stop" position, this valve is closed. Its closure prevents the passage of special oil into the coil assembly, and all the discharged oil is by-passed to the supply tank by way of the special oil return line. When the machine is being operated in the "run" position the quick-opening valve is open. Its being open permits oil to flow into the coil assembly. When the machine is being operated correctly, oil will pass through the quick-opening valve at the rate of 100 gallons per hour. Under these conditions only special oil in excess of 100 gallons per hour flows back to the supply tank through the return line.

d. Other special oil system devices. The locations of all other devices involved in making possible and controlling the flow of special oil are shown in figure 10. Each of these devices is discussed in terms of its function and parts in the immediately succeeding paragraphs.

e. Special oil supply tank. (1) The supply of special oil for the generator is held in the middle one of three large tanks. The tank holds 100 gallons.

(2) The tank is filled through a pipe known as the neck, which extends from the top. Some necks are 2 inches in

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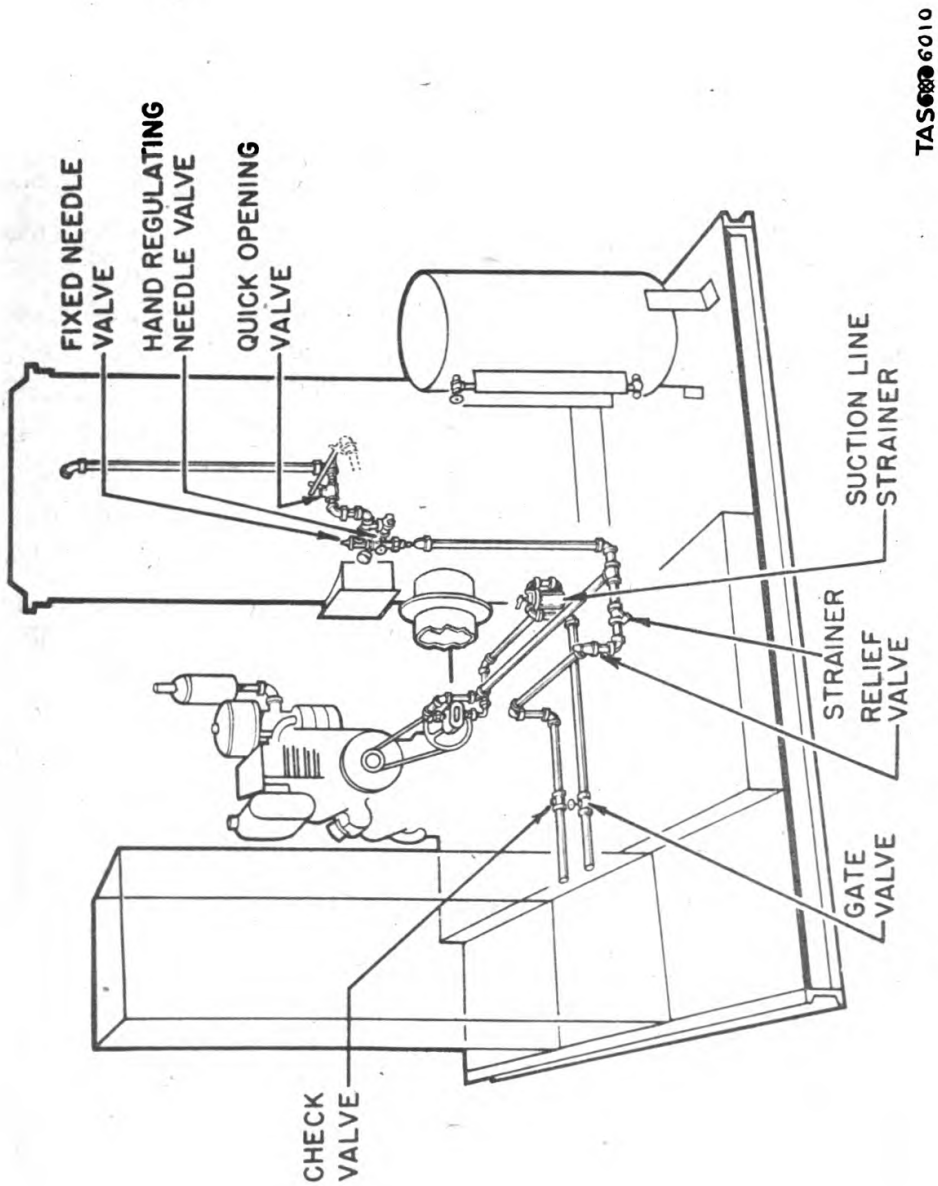

Fig. 10. Other Special Oil System Devices.

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diameter, some 2-1/4 inches. All are closed with appropriately sized caps. Near the neck is a hooked pipe which serves as a vent through which air may escape from the tank. (See fig. 11.)

(3) Also extending from the top of the tank is a gage which shows when the tank is full, three-fourths full, half full, or empty. This gage operates by means of a series of floats

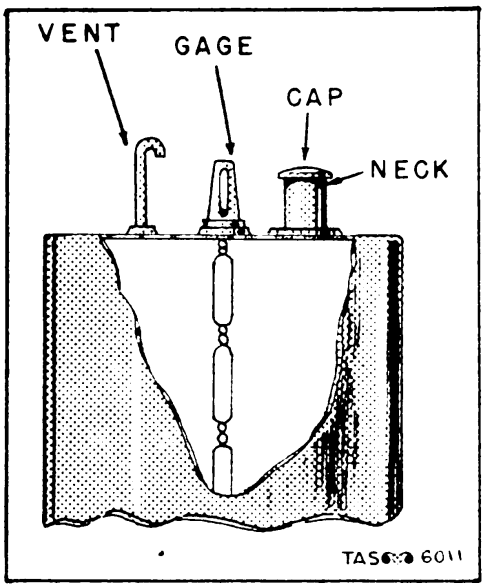

Fig. 11. Upper Half of Supply Tank.

and links. (See fig. 12.) The floats and links are suspended from the gage inside the tank. The metal floats, or "sausages," being very light, float on the liquid. As the liquid descends, the "sausages" descend with it, pulling down the spring inside the glass gage. When the tank is filled, the rising liquid pushes up the sausages, permitting the spring to rise The tank can be emptied through a plug to be found on the engine side below the floor plate. Another method of draining the tank is to disconnect the special oil suction line at the gate valve, open the valve,

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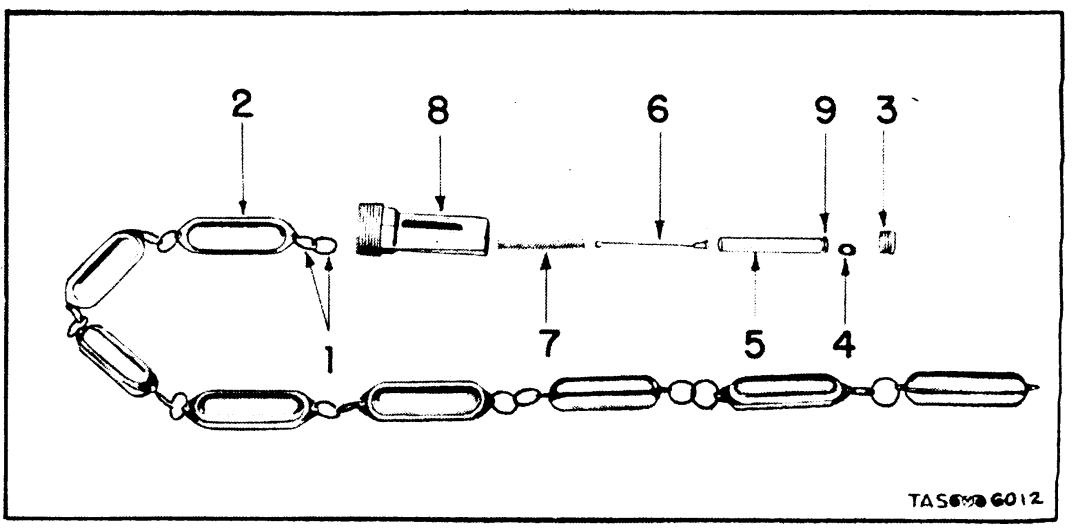
and permit the contents of the tank to escape into a suitable receptacle.

f. Gate valve. (1) The function of the gate valve, as its name indicates, is to control the entrance of special oil into the suction line.

(2) The components of the gate valve are shown in figure 13. By turning the hand-wheel, a disk inside the body of the valve is lifted or lowered. Lifting it permits the entrance of oil into the suction line; lowering it forces the oil to remain in the supply tank.



1. Link.
2. Float.
3. Plug.
4. Washer.
5. Glass Gage.
6. Hook.
7. Spring.
8. Body.
9. Gasket.

Fig. 12. Supply Tank Gage and Floats.

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g. Suction line strainer. (1) The function of the suction line strainer is to catch and retain dirt which the oil may have collected in the supply tank before it reaches the pump. There are two types of special oil suction line strainers, either of which may be employed on the smoke generator. They are the basket-type screen strainer and the self-cleaning strainer.

(2) The components of the basket-type screen strainer are shown in figure 14. The screen is of a very fine mesh.

(3) The components of the self-cleaning strainer are shown in figure 15. Instead of a screen, this strainer is equipped with a cartridge assembly consisting of interlocking stationary and rotating blades. Dirt is caught in these blades and can be shifted to the bottom of the sump by turning the handle.

h. Pump. (1) The pump can discharge a maximum of approximately 125 gallons of special oil per hour into the discharge line.

(2) The pump is a gear type. Its components are shown in figure 16.

i. Return line strainer. (1) The function of this strainer is to catch and retain the last traces of dirt before such of the oil as is by-passing to the supply tank goes through the relief valve.

(2) The return line strainer is a screen type, as described in paragraph 6 g (2) above.

j. Relief valve. (1) The function of the relief valve is to regulate the flow of special oil in the return line.

(2) Components of the relief valve are shown in figure 17. At the factory the poppet of this valve is set so as to give the valve an opening - that is, a relief - of one-half inch.

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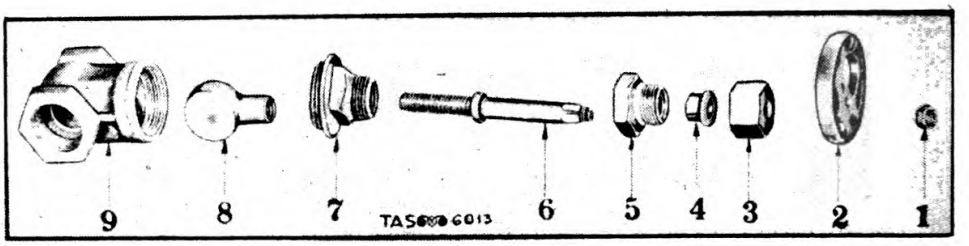
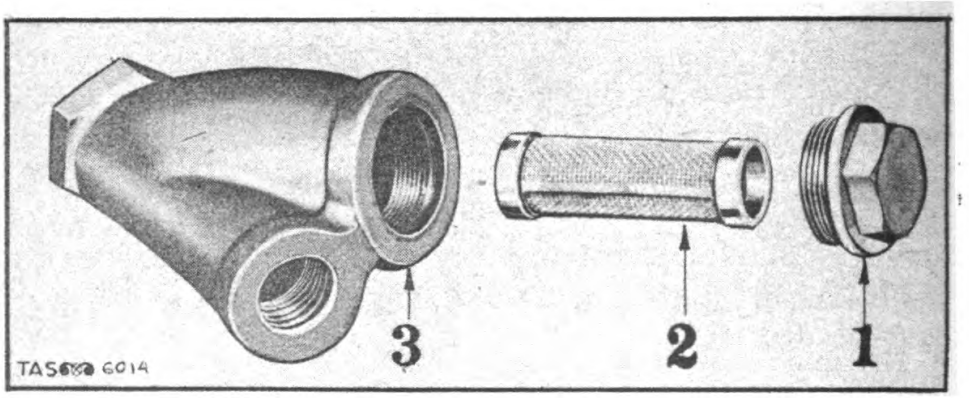


1. Nut.
2. Handwheel.
3. Packing nut.
4. Gland.
5. Stuffing box.
6. Stem.
7. Bonnet.
8. Disk.
9. Body.

Fig. 13. Gate Valve.



1. Cap.
2. Screen.
3. Body.

Fig. 14. Screen-type Strainer.

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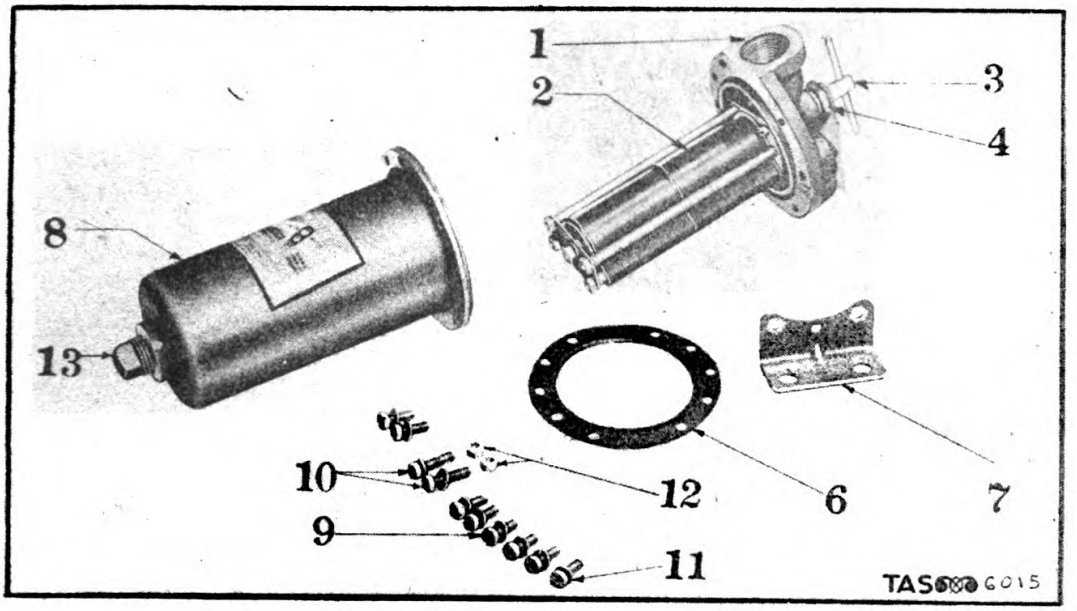
This may have to be varied.

k. Check valve. (1) The function of this valve is to permit special oil flowing into the return line from the discharge line to enter the supply tank and to prevent oil in the tank from escaping into the return line.



1. Head.
2. Cartridge assembly.
3. Handle.
4. Gland nut.
6. Gasket.
7. Mounting bracket.
8. Sump assembly.
9. Sump screws.
10. Sump screws.
11. Washer.
12. Nuts.
13. Drain plug.

Fig. 15. Self-cleaning Strainer.

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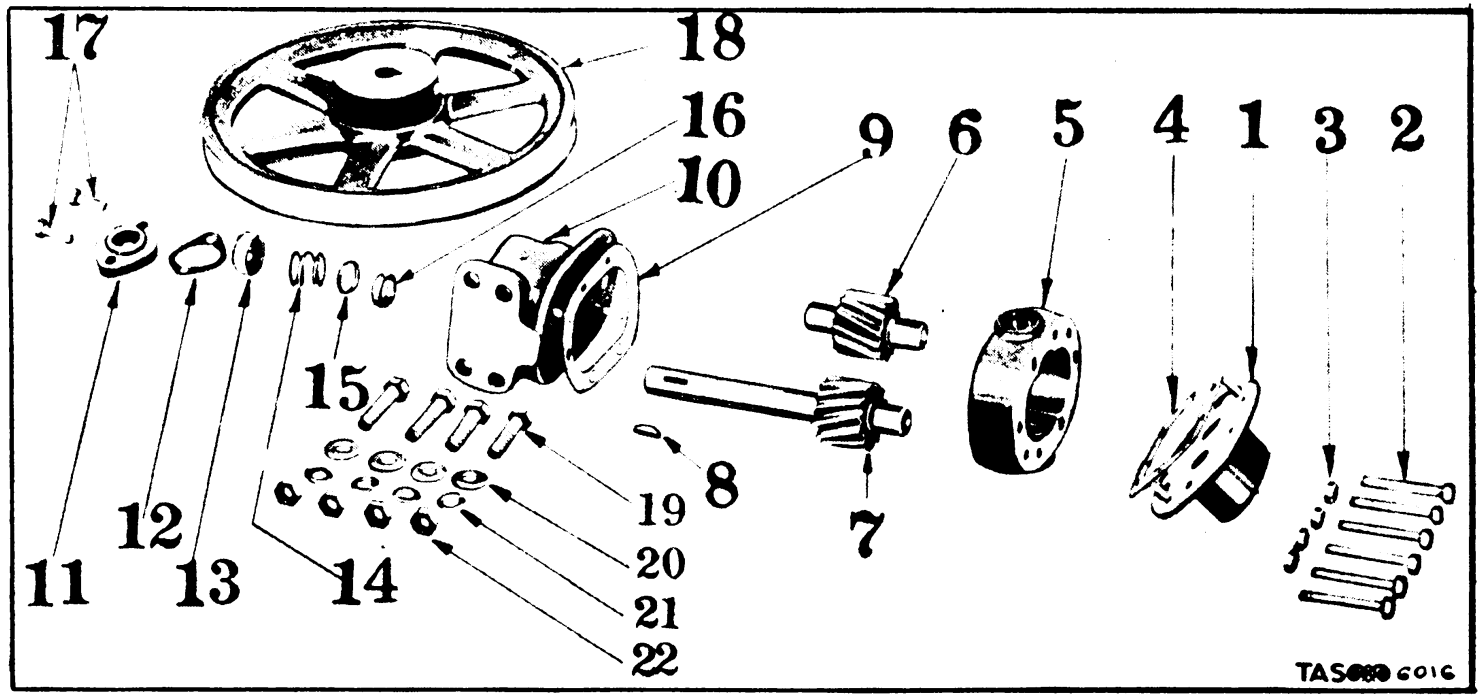

1. End cap.
2. Stand screws.
3. Nuts.
4. Gasket.
5. Housing.
6. Driven gear.
7. Driving gear.
8. Drive pulley key.
9. Gasket.
10. Stand.
11. Seal gland.
12. Gasket.
13. Seal assembly.
14. Spring.
15. Washer.
16. Seal stop.
17. Screws.
18. Pulley.
19. Screws.
20. Plain washer
21. Lock washer
22. Nuts.

Fig. 16. Special Oil Pump.

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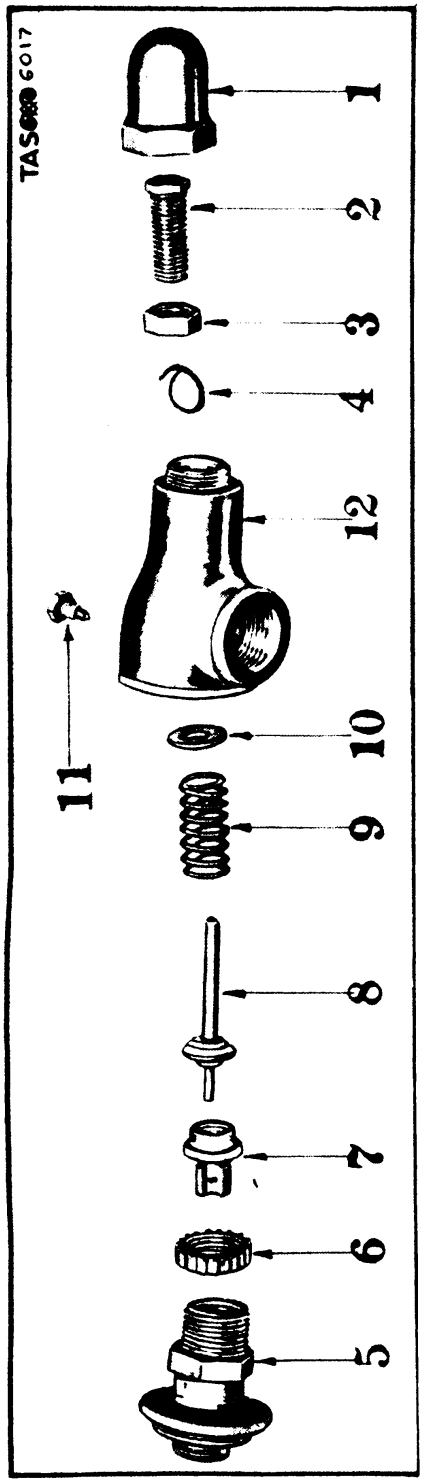

1. Top.
2. Screw.
3. Nut.
4. Packing.
5. Seat.
6. Adjusting nut.
7. Poppet.
8. Stem.
9. Spring.
10. Washer.
11. Screw.
12. Body.

Fig. 17. Relief Valve.

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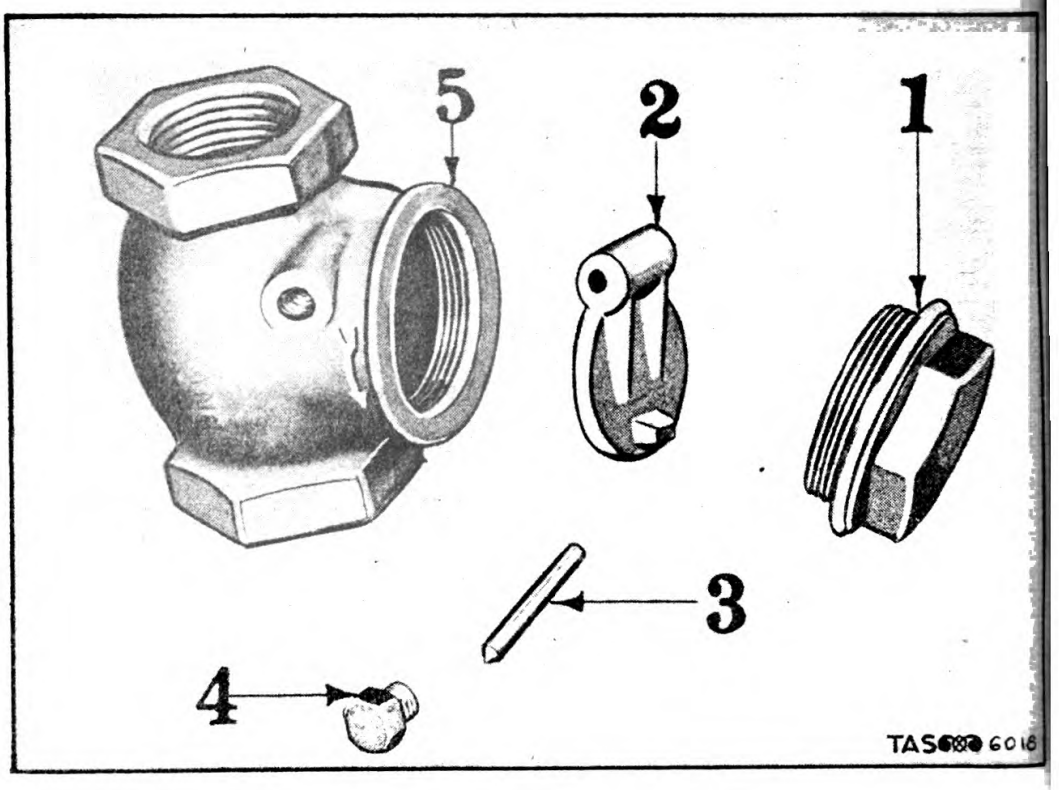
(2) Components of the check valve are shown in figure 18. The disk of the hinge is so set that the pressure of special oil flowing toward the tank will open it. The pressure of oil flowing from the tank merely pushes the disk against the sides of the body, thus preventing the oil from flowing out of the tank into the return line.

1. Fixed needle valve. (1) The function of the fixed



1. Cap.
2. Disk.
3. Hinge pin.
4. Hinge pin plug.
5. Body.

Fig. 18. Check Valve.

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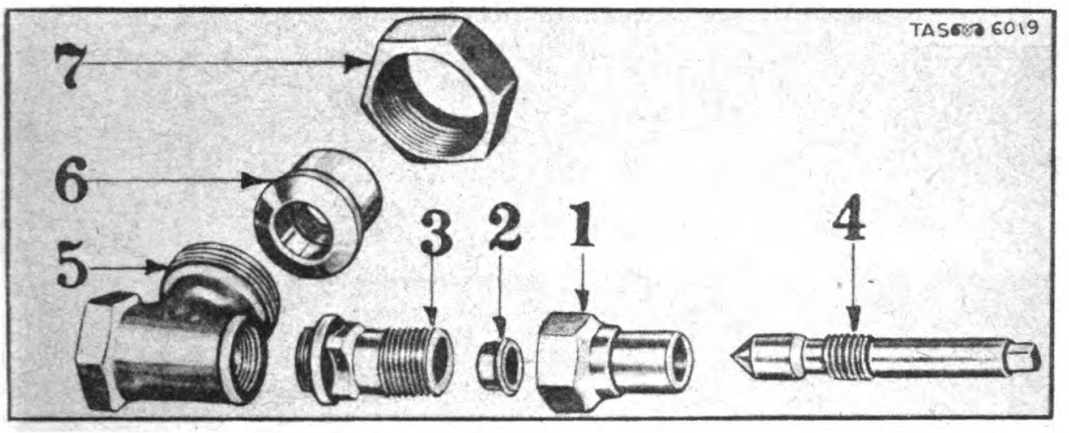
needle valve is to help regulate the flow of special oil through the manifold.

(2) Components of the valve are shown in figure 19. The amount of special oil which this valve will pass is determined by the position of the stem inside the valve body. At the factory this stem is set so that the valve permits the passage



1. Top.
2. Bushing.
3. Gland.
4. Stem.
5. Body.
6. Adapter.
7. Adapter nut.

Fig. 19. Fixed Needle Valve.

of 70 gallons of special oil per hour at room temperatures. Adjustments may be made by turning the stem, this operation being accomplished by means of a regulating key which is found in the tool box on the frame of the mechanical smoke generator.

m. Hand-regulating needle valve. (1) This valve functions in conjunction with the fixed needle valve to regulate the flow of special oil through the manifold.

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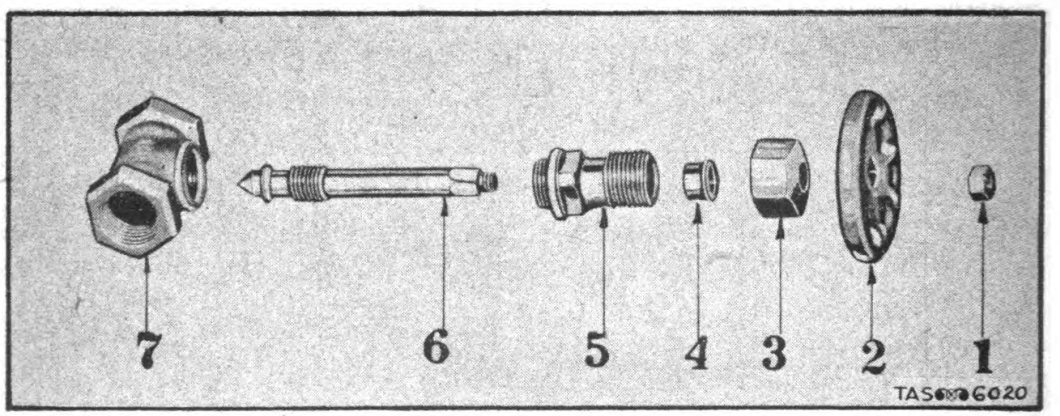
(2) Components of the valve are shown in figure 20. Maximum operation of the smoke generator demands the passage through the manifold of 100 gallons of special oil an hour. The fixed needle valve, as originally set, permits the passage of only 70. Proper adjustment of the hand-regulating needle valve allows a maximum of 30 more gallons to pass. This adjustment is accomplished by turning the hand-wheel.

n. Quick-opening valve. (1) The function of the special oil quick-opening valve is to regulate the passage of special oil from the manifold into the coil assembly.

(2) Components of the special oil quick-opening



1. Nut.
2. Handwheel.
3. Gland nut.
4. Bushing.
5. Gland.
6. Stem.
7. Body.

Fig. 20. Hand-regulating Needle Valve.

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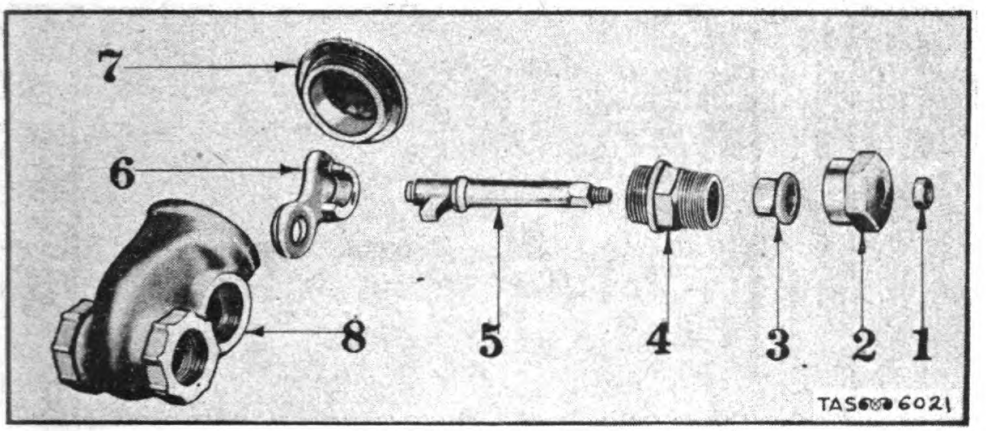
alve are shown in figure 21. The construction of this valve is milar to that of the gate valve on the special oil suction line. stead of the disk of the valve being raised or lowered to open r close the valve, however, it swings on a stem.



1. Lever nut.
2. Packing nut.
3. Gland.
4. Stuffing box.
5. Stem.
6. Disk.
7. Cap.
8. Body.

Fig. 21. Quick-opening Valve.

7. WATER SYSTEM. a. Definition. The water system onsists of all piping and devices directly involved in making ossible and controlling the flow of water from the water sup- ly tank to the coil assembly.

b. Piping. The piping which carries water from the ater supply tank to the water coil is diagrammed in figure 22. consists of five main sections:

(1) Suction line. This extends from supply tank tc ump.

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(2) Discharge line. This extends from the pump to a 1/2-inch union at the base of the water manifold.

(3) Accumulator extension. This extends from a 1/2-inch tee on the discharge line to the accumulator.

(4) Manifold. This name is given to all water piping between the termination of the discharge line and the water coil.

(5) Return line. This extends from a 1/2-inch tee on the discharge line, as shown in figure 22, back to the supply tank.

c. Flow. Taking suction from the supply tank, the pump draws water through the suction line and then discharges it into the discharge line from whence it flows through the accumulator extension into the base of the accumulator. In about 3 minutes enough water accumulates to produce at the top of the accumulator an air cushion of such force that the water is driven up the vertical section of the discharge line into the manifold from whence it travels into the coil assembly. On the manifold are a number of devices designed to limit the amount of water which may reach the coil. Excess water over and above that stored in the accumulator by-passes to the supply tank by way of the water return line.

d. Other water system devices. (1) The locations of all other devices involved in making possible and controlling the flow of water are shown in figure 23.

(2) Some of the devices on the water system are practically the same in function and construction as devices bearing the same names on the special oil system. For this reason the following water system devices need not be described in detail: supply tank, gate valve, relief valve, return line check valve, and quick-opening valve. Each of the other devices

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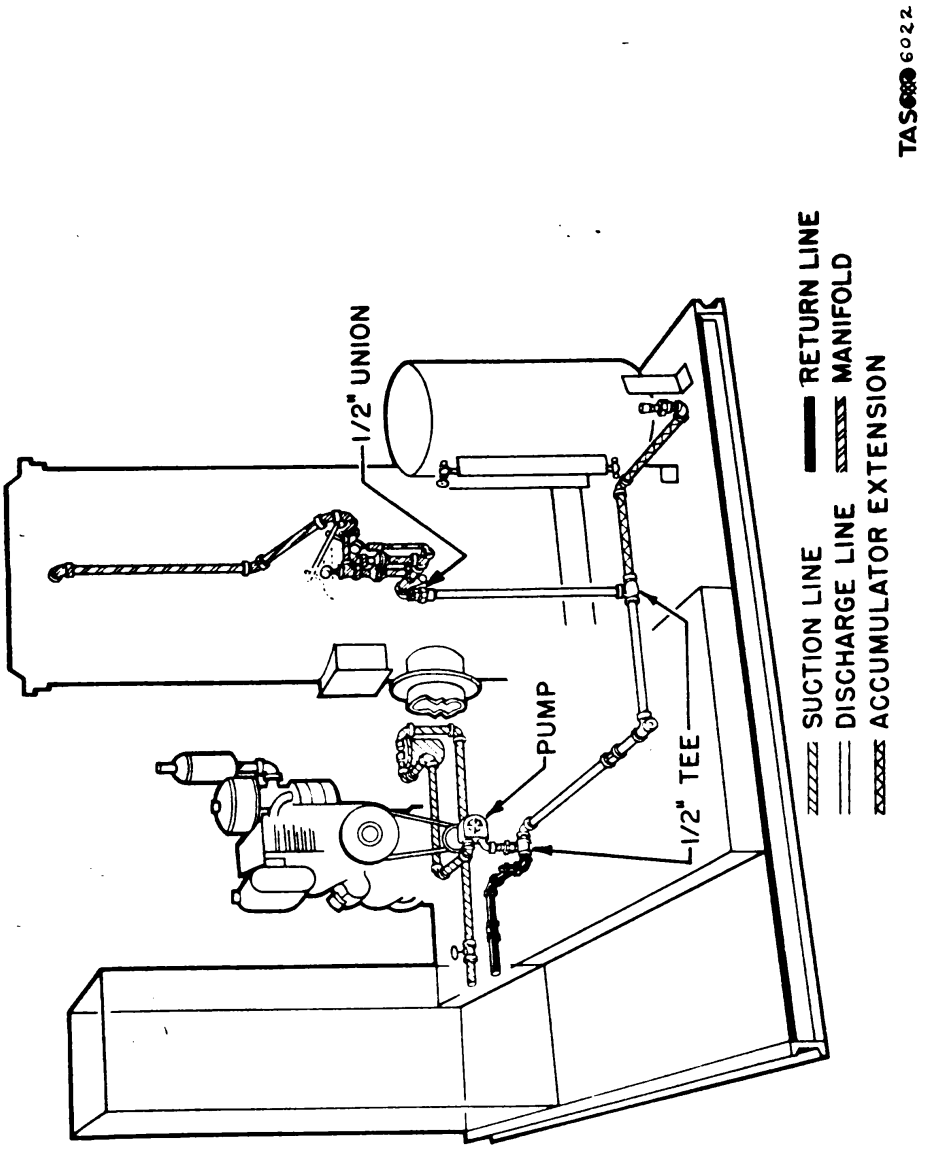

Fig. 22. Water System Piping.

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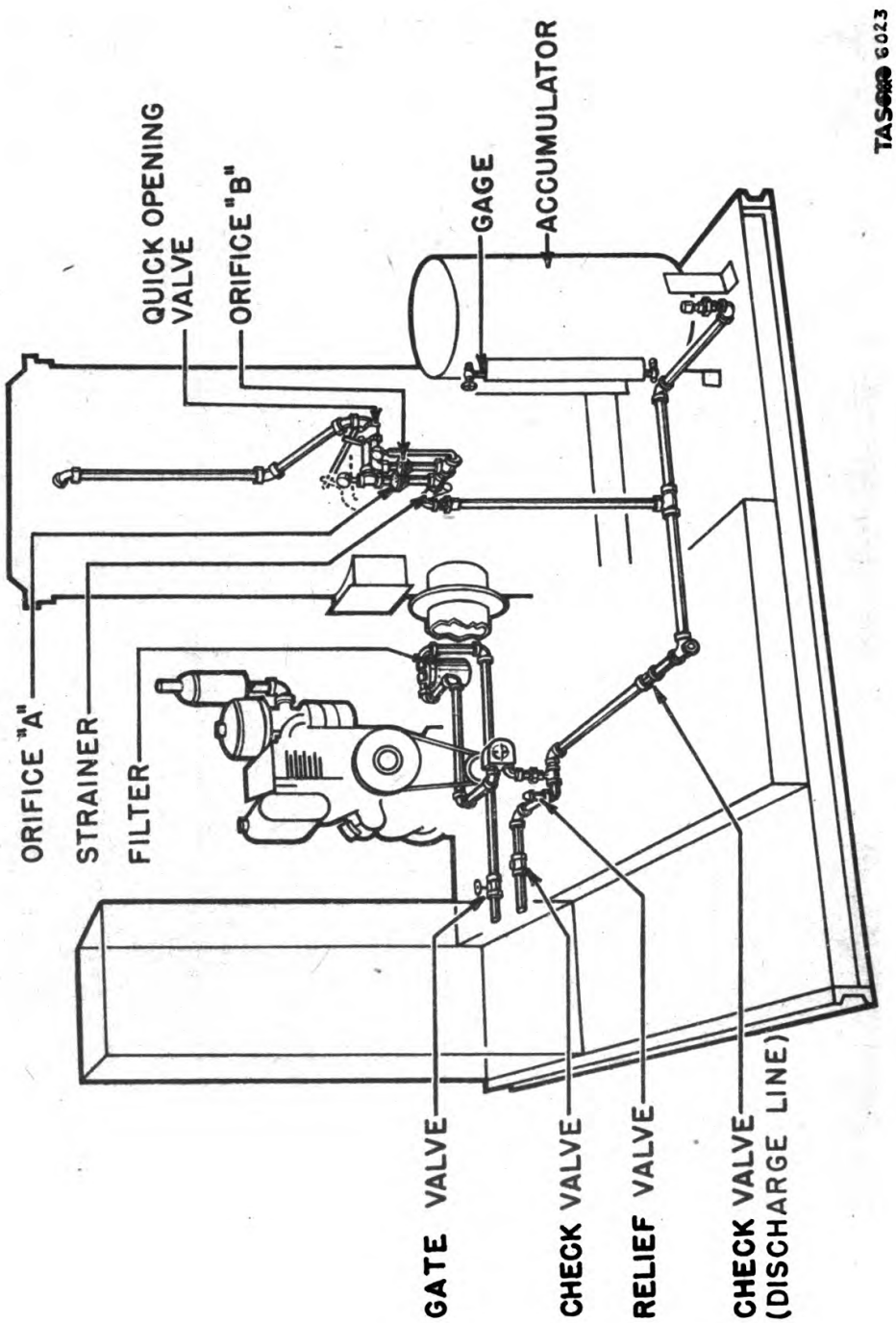

Fig. 23. Other Water System Devices.

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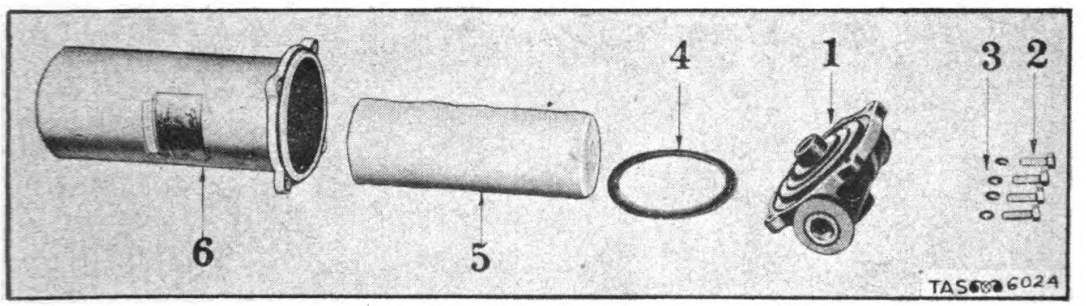
is described in terms of its function and components in the immediately following paragraphs.

e. Filter. (1) The function of the filter is to remove and retain dirt before water passes into the pump.



1. Head.
2. Screws.
3. Washers.
4. Gasket.
5. Element.
6. Shell.

Fig. 24. Water Filter.

(2) Components of the water filter are shown in figure 24. The filtering element is a tubular body of bleached cotton yarn. The yarn is wound on a wire mesh tube so as to form a honeycomb of deep tapered tunnels. As each layer is wound, a thin screen of parallel fibres is drawn across each layer of yarn, producing a series of interlaced filter sheets, each of which is locked into place by the subsequent layer of yarn. A filter wall thickness of approximately 1/2-inch is thus attained. Water being drawn through these funnels from the outside to the inside of the tube passes through a manifold series of filter sheets which remove and retain sediment.

f. Pump. (1) The function of the pump is to deliver

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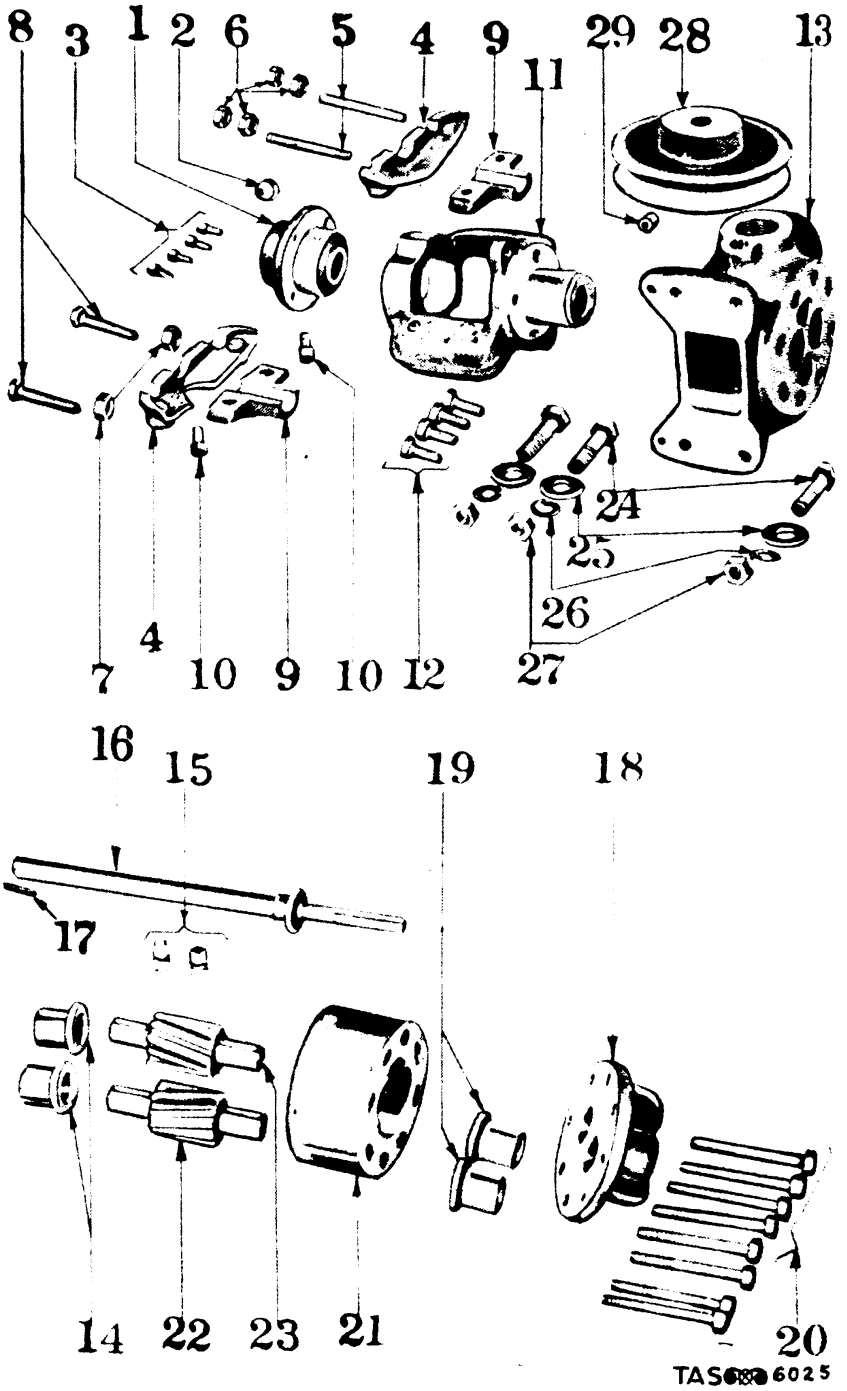

Fig. 25. Water Pump.

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1. Bearing cage.
2. Alemite fitting.
3. Screw.
4. Packing gland caps.
5. Studs.
6. and 7. Nuts.
8. Screws.
9. and 10. Packing gland assembly.
11. Packing box housing.
12. Screws.
13. Backplate.
14. Flanged bearing bushing cams.
15. Pipe plug.
16. Drive shaft.
17. Key.
18. Faceplate.
19. Flanged bearing bushing cams.
20. Screws.
21. Case.
22. Left-hand spiral cam and shaft.
23. Right-hand spiral cam and shaft.
24. Screws.
25. Flat washers.
26. Lock washers.
27. Nuts.
28. Pulley.
29. Allen head set screw.

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water throughout the system.

(2) Components of the pump are shown in figure 25. It is a rotary gear-type pump.

g. Water discharge line check valve. (1) The chief function of this valve is to make possible the flushing and cleansing of the coil assembly following each run of the generator.

(2) Constructed similarly to the check valves on the special oil and water return lines, the valve is arranged to pass water discharged from the pump, but to prevent the passage of water flowing from the accumulator. Water flows from the accumulator whenever the water pump is shut down. Blocked by the discharge line check valve, much of this water is forced up into the water manifold, from there into the coil assembly, and from there into the atmosphere through the spray nozzle manifold.

h. Accumulator. (1) The principal function of the accumulator is to provide compressed air to drive water through the water manifold in an amount compatible with the needs of the generator.

(2) Components of the accumulator are shown in figure 26. The gage shows the height of water in the accumulator.

i. Water manifold strainer. (1) The function of this part is to remove dirt prior to the passage of the water through the orifices.

(2) It is similar in construction to the screen-type strainers used on the special oil system.

j. Orifices A and B. (1) In conjunction with the water quick-opening valve these orifices limit the amount of water which may pass to the coil assembly. Each orifice is built to

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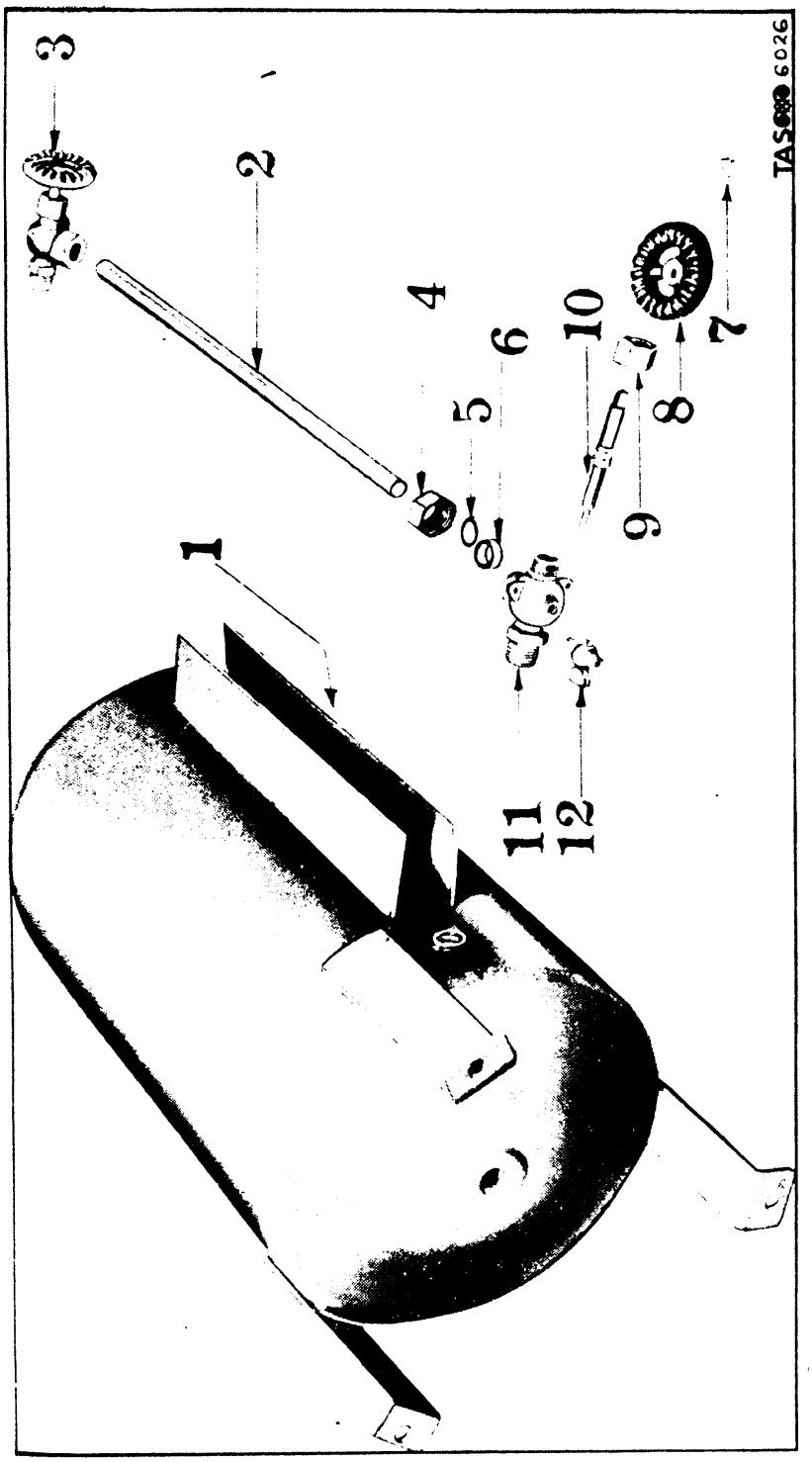

1. Tank.
2. Glass gage.
3. Upper arm valve assembly.
4. Glass nut.
5. Brass washer.
6. Rubber washer.
7. Screw.
8. Wheel.
9. Packing nut.
10. Valve stem.
11. Valve body.
12. Petcock.

Fig. 26. Accumulator.

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permit the passage of about 6 gallons per hour.

(2) Components of water orifices are shown in figure 27.

8. FUEL OIL SYSTEM. a. Definition. The fuel oil system consists of all piping and devices involved in the flow and ignition of fuel oil.

b. Piping. The copper tubing which carries fuel oil from the fuel oil supply tank to the atomizing nozzle body inside the air tube of the fuel oil burner is diagrammed in figure 28. It consists of five main sections:

(1) Suction line. This extends from the supply tank to the pump.

(2) Discharge pipe. This extends from pump to pressure regulating valve.

(3) Outer discharge tubing. This extends from base of pressure regulating valve to shut-off valve.

(4) Inner discharge tubing. This, running inside the air tube of the fuel oil burner, extends from shut-off valve to atomizing nozzle body.

(5) Return line. This extends from a 3/8-inch adapter elbow (figure 28) on the discharge pipe back to the supply tank.

c. Air supply. The air necessary for combustion of the fuel oil is drawn into the burner fan past the air control plate in the guard and pump assembly and forced under pressure into the air tube and combustion head assembly where it mixes with the fuel oil at the atomizing nozzles. Combustion is completed in the firebox.

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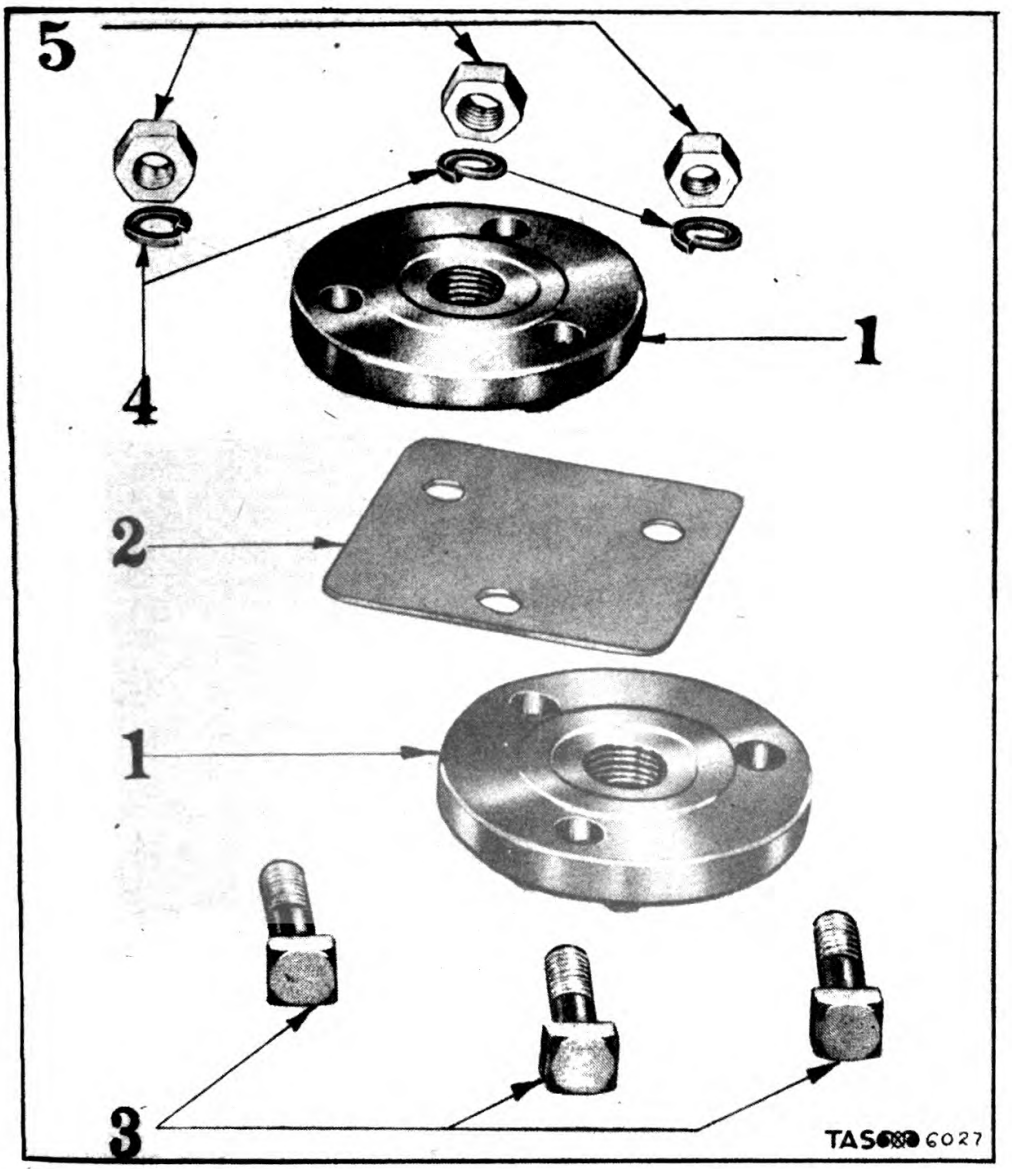

1. Flanges.
2. Orifice.
3. Bolt.
4. Washer.
5. Nut.

Fig. 27. Orifices.

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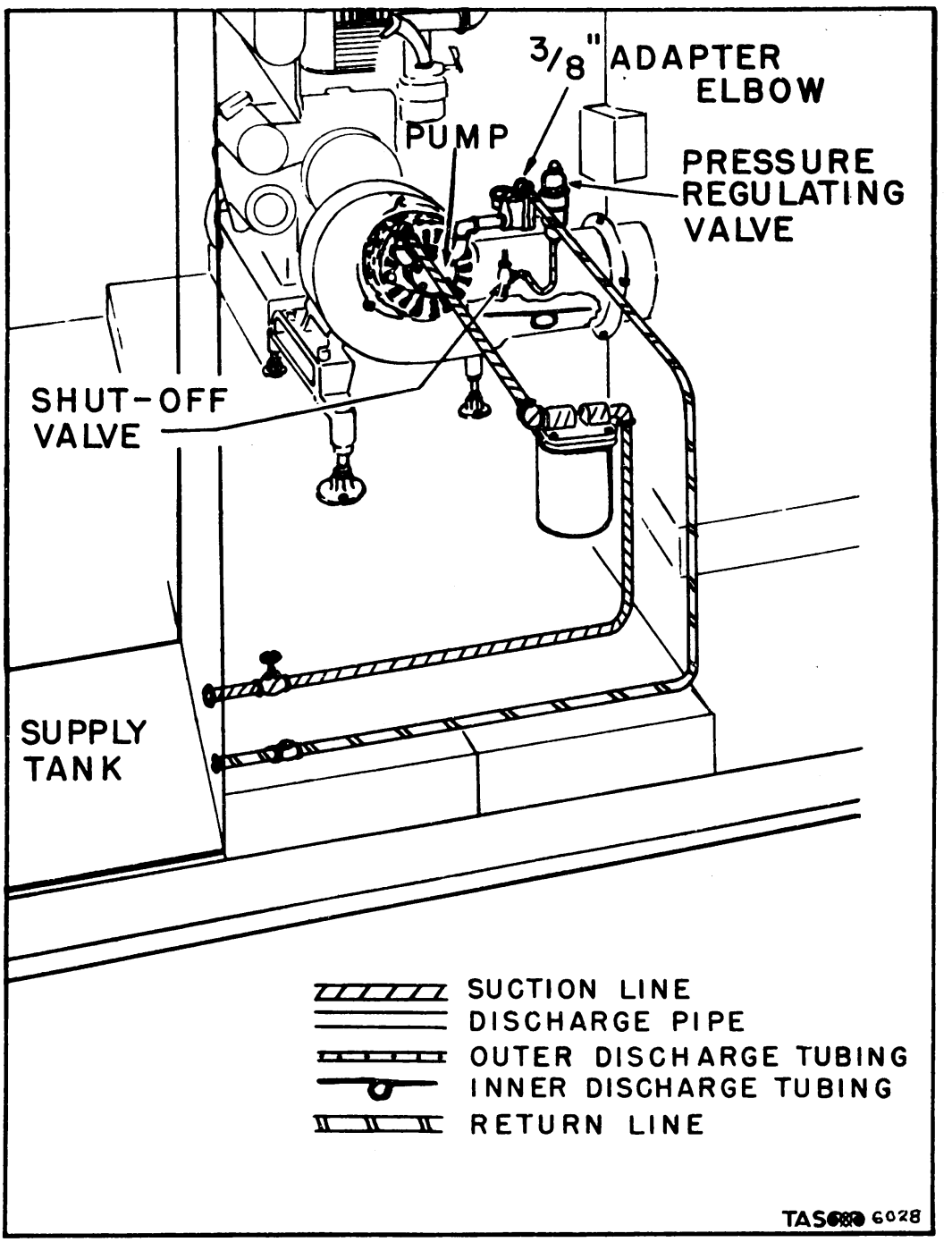

Fig. 28. Fuel Oil System Piping.

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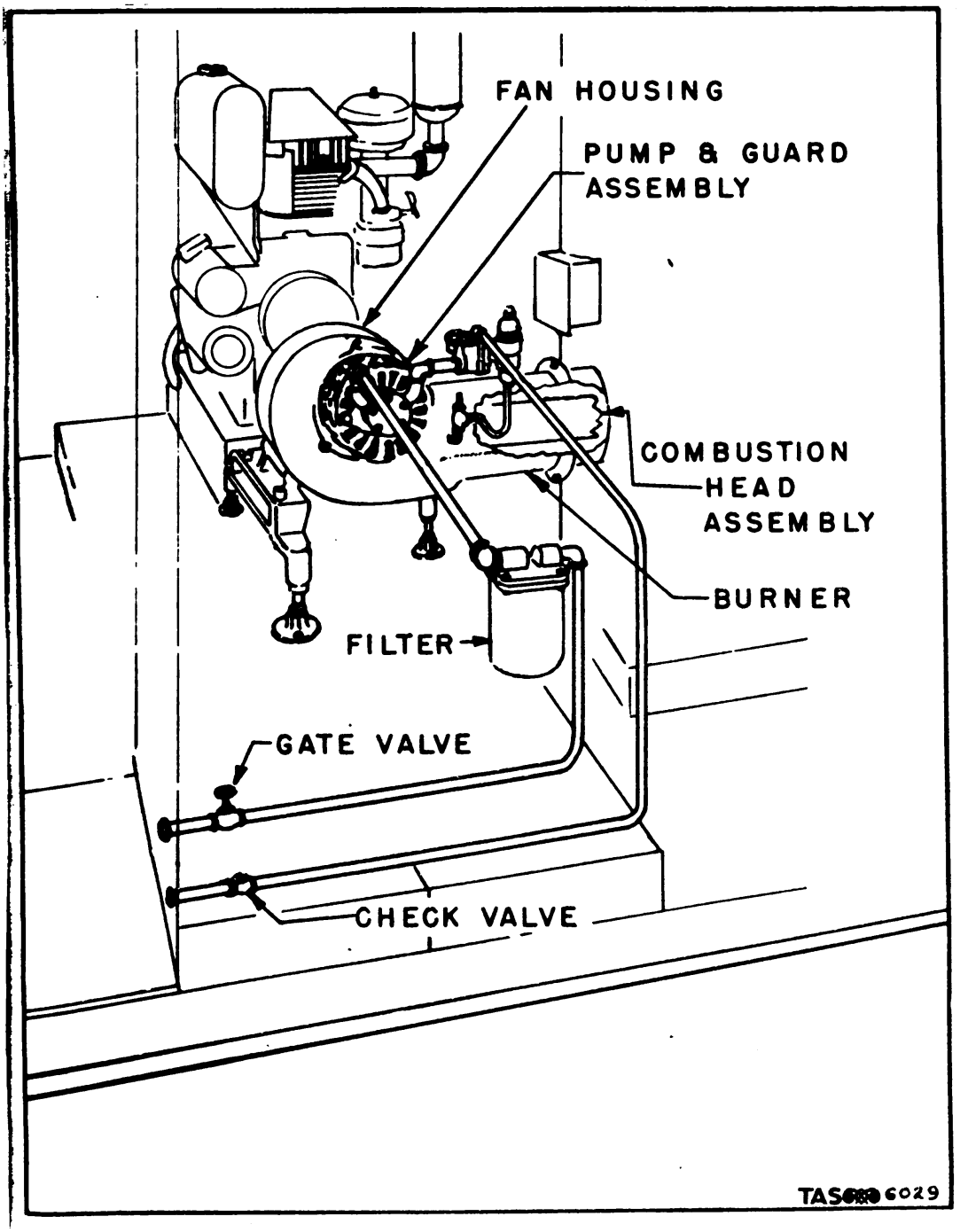

Fig. 29. Other Fuel Oil System Devices.

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d. Flow. Taking suction from the supply tank, the pump draws fuel oil through the suction line and then discharges the oil into the discharge pipe. In the discharge pipe the oil flows to the pressure regulating valve. This valve permits only a portion of the oil to pass, excess oil by-passing to the supply tank through the fuel oil return line. Such oil as passes the pressure valve continues through the inner and outer discharge tubings and the atomizing nozzle body to the two atomizing nozzles where it is atomized - that is, converted to spray - and where it mixes with air from the burner fan to form a fuel oil spray-air mixture known as the burner mixture. As this mixture emerges from the nozzles into the firebox it is ignited by a spark between two electrodes. These electrodes are located so that the spark is just above but not in the emerging burner mixture.

e. Other fuel oil system devices. The location of all other devices pertinent to the functioning of the fuel oil system is shown in figure 29. Some of these devices are similar in build and function to special oil system devices bearing the same names. For this reason no detailed description is needed of the supply tank, gate valve, and check valve. It should be noted further that the fuel oil filter is similar in build and function to the filter on the suction line of the water system. (See fig. 30.) Each of the other devices is described in terms of its function and parts in the immediately following paragraphs.

f. Pressure regulating valve. (1) The function of this valve is to regulate the pressure of the fuel oil as it enters the discharge tubing which leads into the burner. This is necessary for the reason that the atomizing nozzles inside the burner can atomize only 7.5 gallons of fuel oil per hour at 130 pounds per square inch operating pressure.

(2) Components of the valve are shown in figure 31. It is a single adjustment, bellows actuated, needle valve with a pressure range of 75 to 150 pounds per square inch

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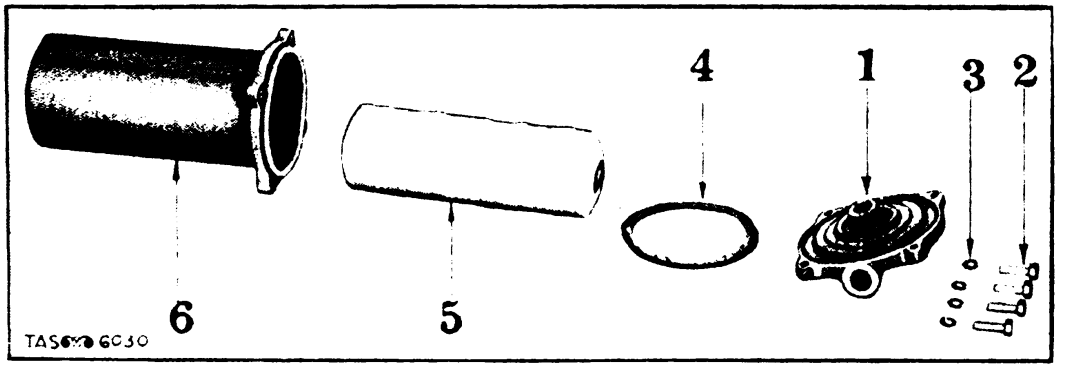

1. Head.
2. Screw.
3. Washer.
4. Gasket.
5. Tube and core.
6. Shell.

Fig. 30. Fuel Oil Filter.

g. Shut-off valve. (1) The function is to regulate flow of fuel oil from outer discharge tubing into inner discharge tubing.

(2) Components of the valve are shown in figure 32. On magneto-ignition generators the valve is adjusted with a key rather than with the hand-wheel shown. On either model the shut-off valve is a needle valve, similar in build and operation to the fixed needle valve on the special oil manifold.

h. Pump. The pump is a rotary, internal gear type with a capacity of approximately 18 gallons per hour at 1,800 revolutions per minute and 130 pounds per square inch. (See figs. 33 and 37.)

i. Burner. (See fig. 34.) (1) The function of the burner is to atomize and ignite the fuel oil.

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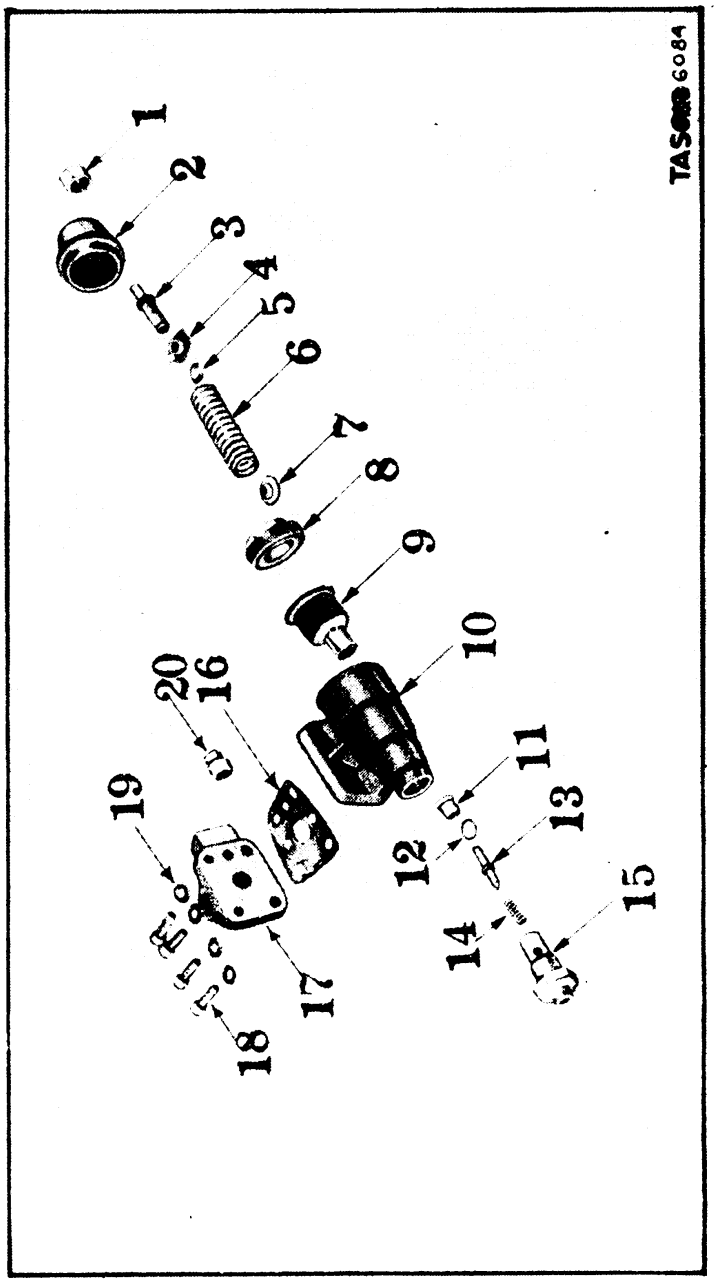

1. Nut.
2. Cap.
3. Stem.
4. Fitting.
5. Lock.
6. Spring.
7. Washer.
8. Base.
9. Valve.
10. Body.
11. Seat.
12. Gasket.
13. Stem.
14. Spring.
15. Seat.
16. Gasket.
17. Fitting.
18. Screws.
19. Washers.
20. Pipe plug.

Fig. 31. Pressure-regulating Valve.

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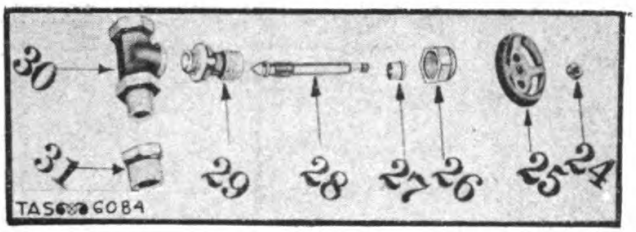

24. Wheel nut.
25. Hand wheel.
26. Stuff nut.
27. Follower.
28. Stem.
29. Seat.
30. Body.
31. Close nipple.

Fig. 32. Shut-off Valve.

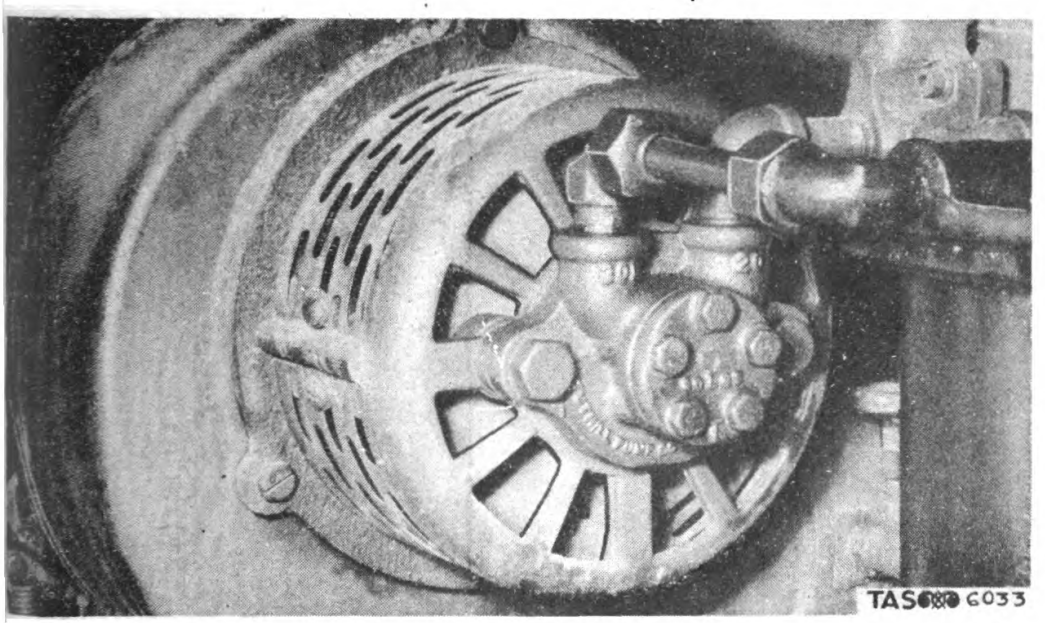

Fig. 33. Fuel Oil Pump.

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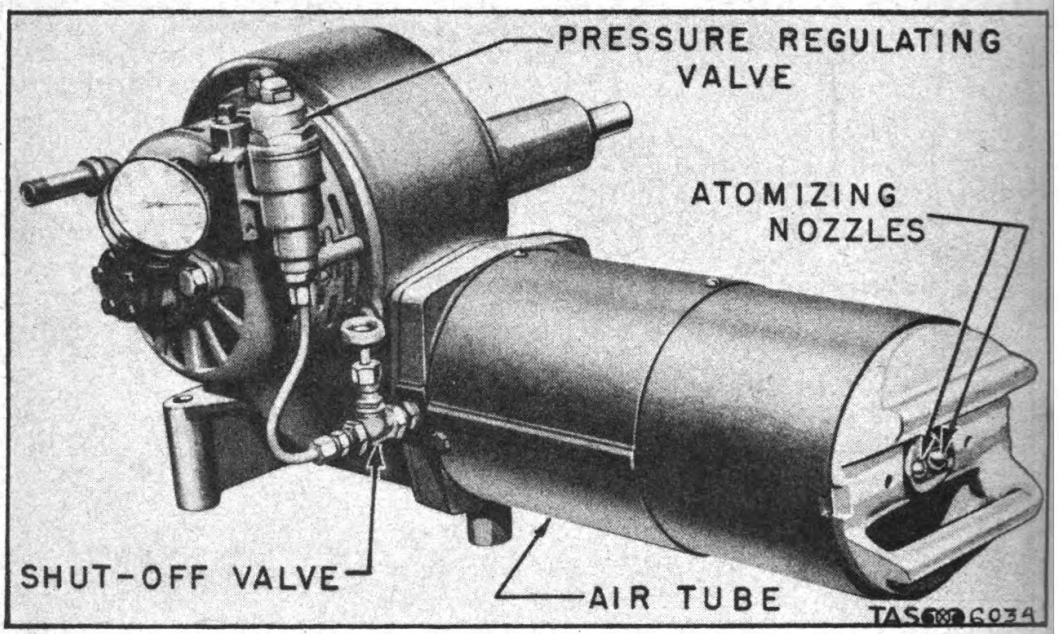

Fig. 34. Burner.

(2) The burner may be said to consist of three main parts:

(a) Fan assembly. (See fig. 36.)

(b) Combustion head assembly. (See fig. 38.)

(c) Air tube. (See fig. 39.)

(3) As previously noted, it is the function of the burner fan to drive air into the combustion head assembly where it mixes with fuel oil spray at the atomizing nozzles to effect combustion.

(4) The air tube holds the inner discharge tubing and the combustion head assembly. Air goes through the tube to the combustion head.

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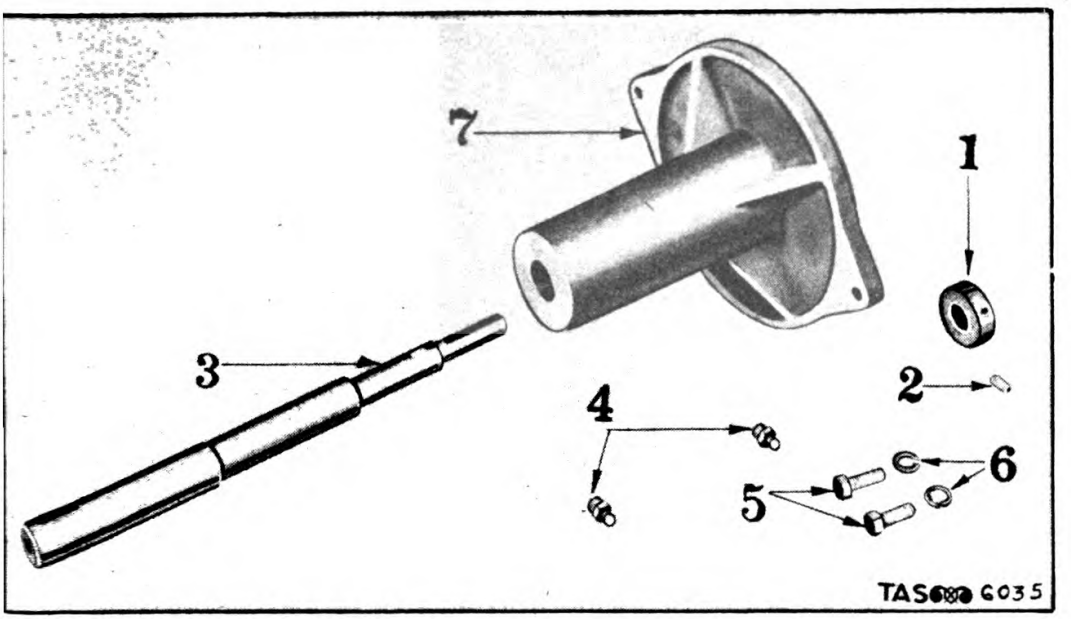
(5) To reach the atomizing nozzles, fuel oil passes through the nozzle pipe and body. Inside the pipe is a screen which removes dirt from the oil before it reaches the nozzles. Air, coming through the tube, flows into the combustion head, thus reaching the nozzles, where it mixes with the incoming fuel oil. The electrodes provide the spark necessary to ignite the resulting burner mixture as it emerges from the nozzles into the firebox at the base of the furnace.



1. Collar.
2. Set screw.
3. Driveshaft.
4. Fittings.
5. Attaching screw.
6. Lock washers.
7. Outboard bearing and bushing assembly.

Fig. 35. Burner Outboard Bearing and Shaft.

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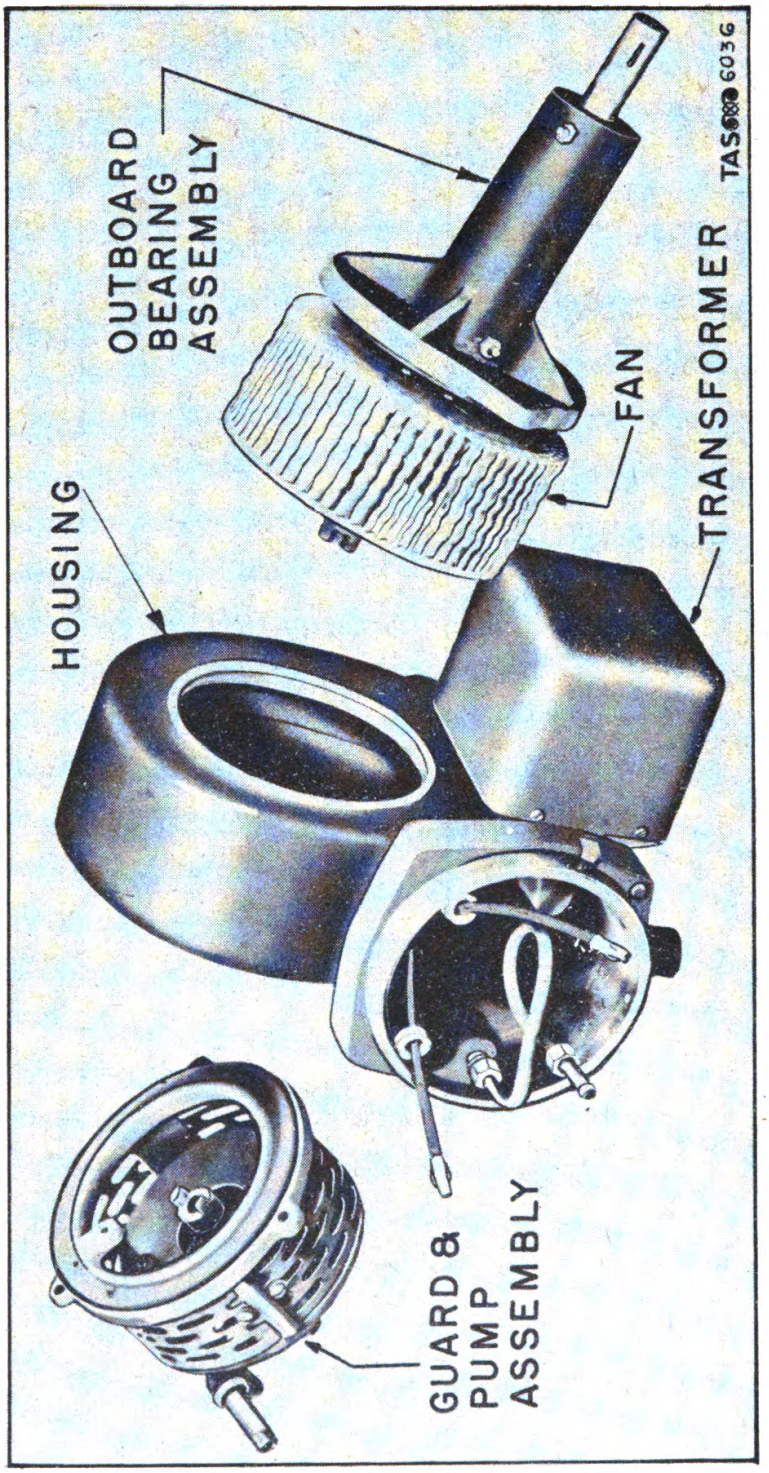

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1. Air guard cover.
2. Cover screw.
3. Washer.
4. Air guard.
5. Cap screw.
6. Flexible coupling.
7. Coupling set screw.
8. Control plate.
9. Control plate adjusting screw.
10. Control plate screw spring.
11. Washer.
12. Cotter pin.
13. 3/8" x 2-1/4" pump nipple.
14. 3/8" street elbow.
15. Fuel oil pump.
16. Screw.

Fig. 37. Pump and Guard Assembly.

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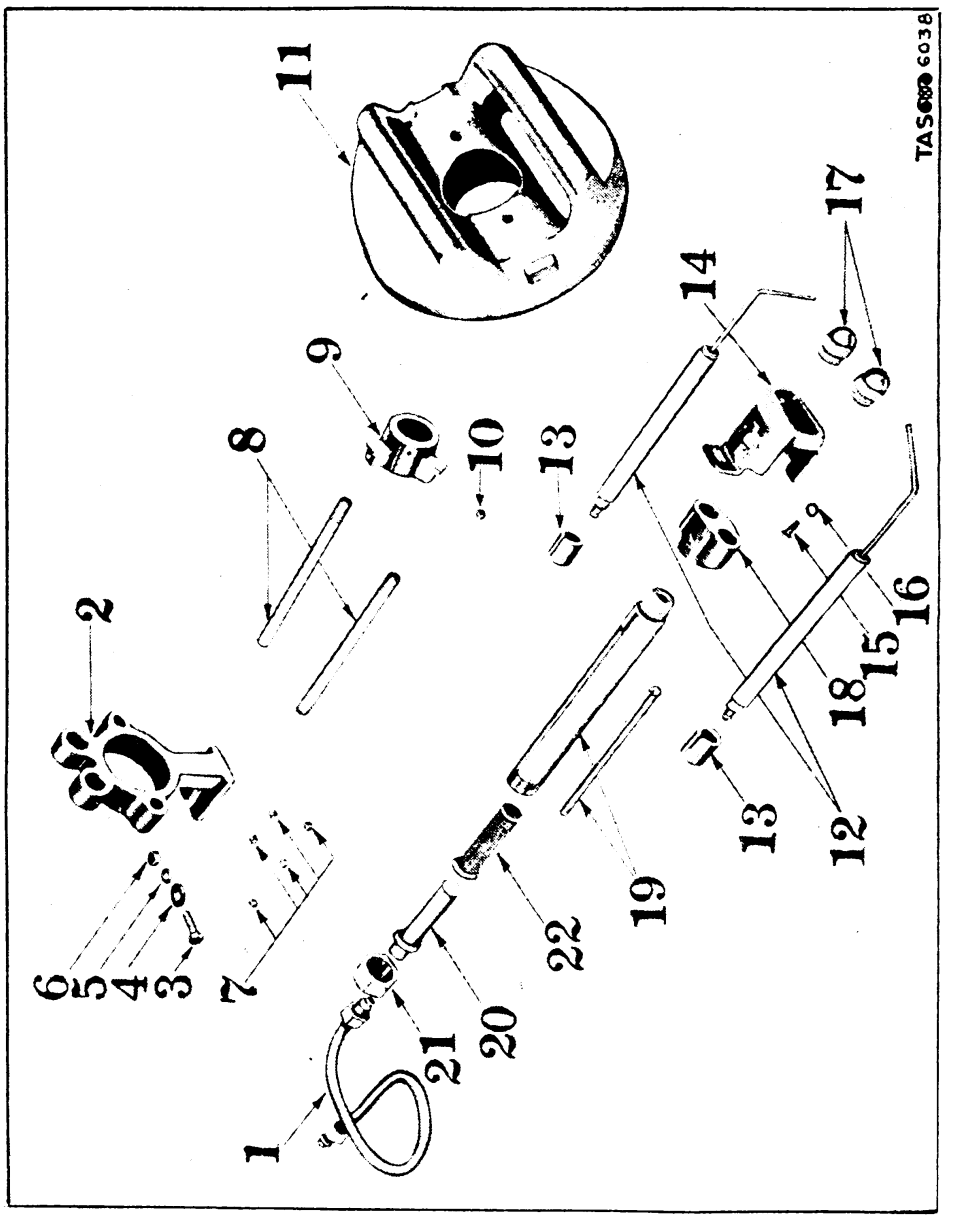

Fig. 38. Combustion Head Assembly.

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1. Inner fuel oil discharge tubing.
2. Ignition tube bracket.
3. Bracket screw.
4. Washer.
5. Washer.
6. Nut.
7. Set screw.
8. Stay rod.
9. Ignition tube bracket spider.
10. Spider set screw.
11. Combustion head.
12. Electrode assembly.
13. Sleeve.
14. Shield.
15. Screw.
16. Washer.
17. Atomizing nozzles.
18. Nozzle body.
19. Nozzle pipe, with inner rod.
20. Nozzle pipe connector.
21. Nozzle pipe connector nut.
22. Nozzle pipe screen.

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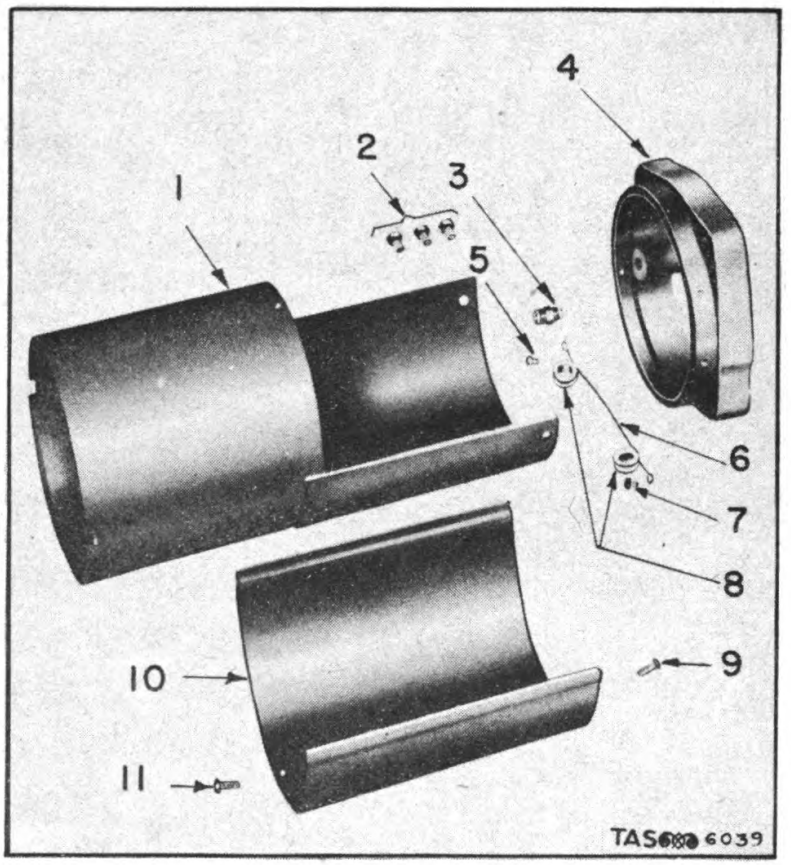

1. Air tube assembly, less cover.
2. Air tube screw.
3. Air tube adapter compression coupling (to nozzle pipe).
4. Air tube adapter.
5. Ignition wire spacer screw.
6. Bushing spacer wire.
7. Ignition wire spacer screw
8. Ignition wire spacer bushing.
9. Cover screw.
10. Cover.
11. Cover screw.

Fig. 39. Air Tube.

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9. HEATING SYSTEM. a. Definition. The heating system consists of the furnace (fig. 40) and other devices immediately involved in the heating, super-heating, and final passage of special oil and water for the purpose of creating smoke.

b. Smoke formation. (See also par. 4 above.) As previously explained, special oil enters the furnace at the injector of the coil assembly inside the furnace shell. Water enters the furnace at the water coil inlet and is heated by the firebox as it flows through the water coil. Meeting the cold special oil at the injector, the vaporized water disperses finely throughout the oil From the injector the special oil-vapor mixture flows through the special oil-vapor coil and is super-heated in the firebox. The super-heated mixture escapes through the spray nozzle manifold into the air where rapid chilling condenses it into smoke.

c. Furnace shell. (1) Function of the furnace shell is to insulate the firebox and coil assembly.

(2) The insulating materials used in the furnace shell are shown in figure 41.

d. Firebox. The firebox serves as a combustion chamber for the ignited burner mixture entering through the atomizing nozzles in the combustion head of the burner. Function of the burning mixture is to heat and super-heat the special oil and water flowing through the coil assembly above.

e. Coil assembly. The coil assembly parts are shown in figure 42. They are:

(1) 33 feet of 1/2-inch piping constituting the water coil.

(2) 140 feet of 1-inch piping constituting the special oil-vapor coil.

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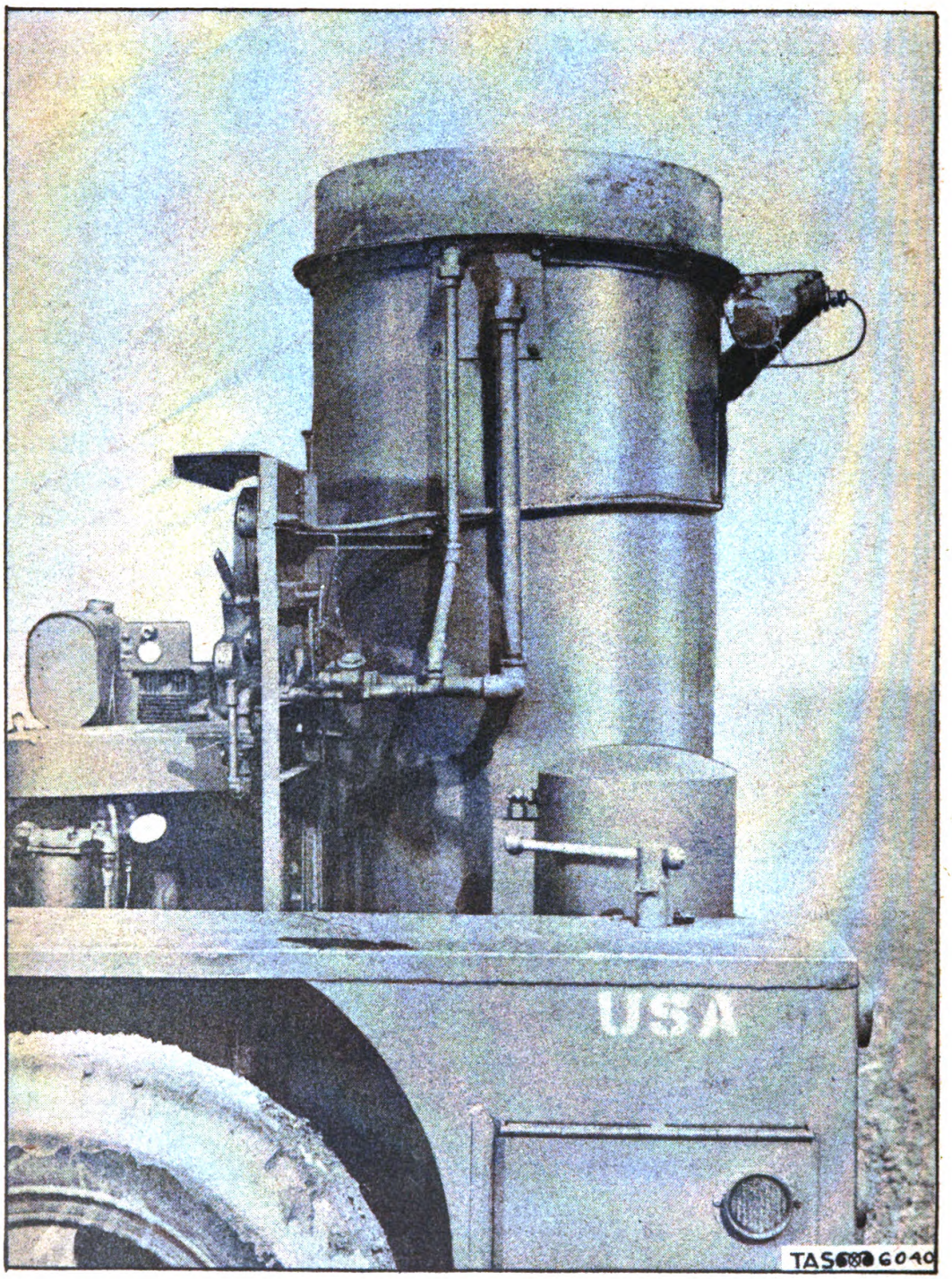

Fig. 40. Furnace.

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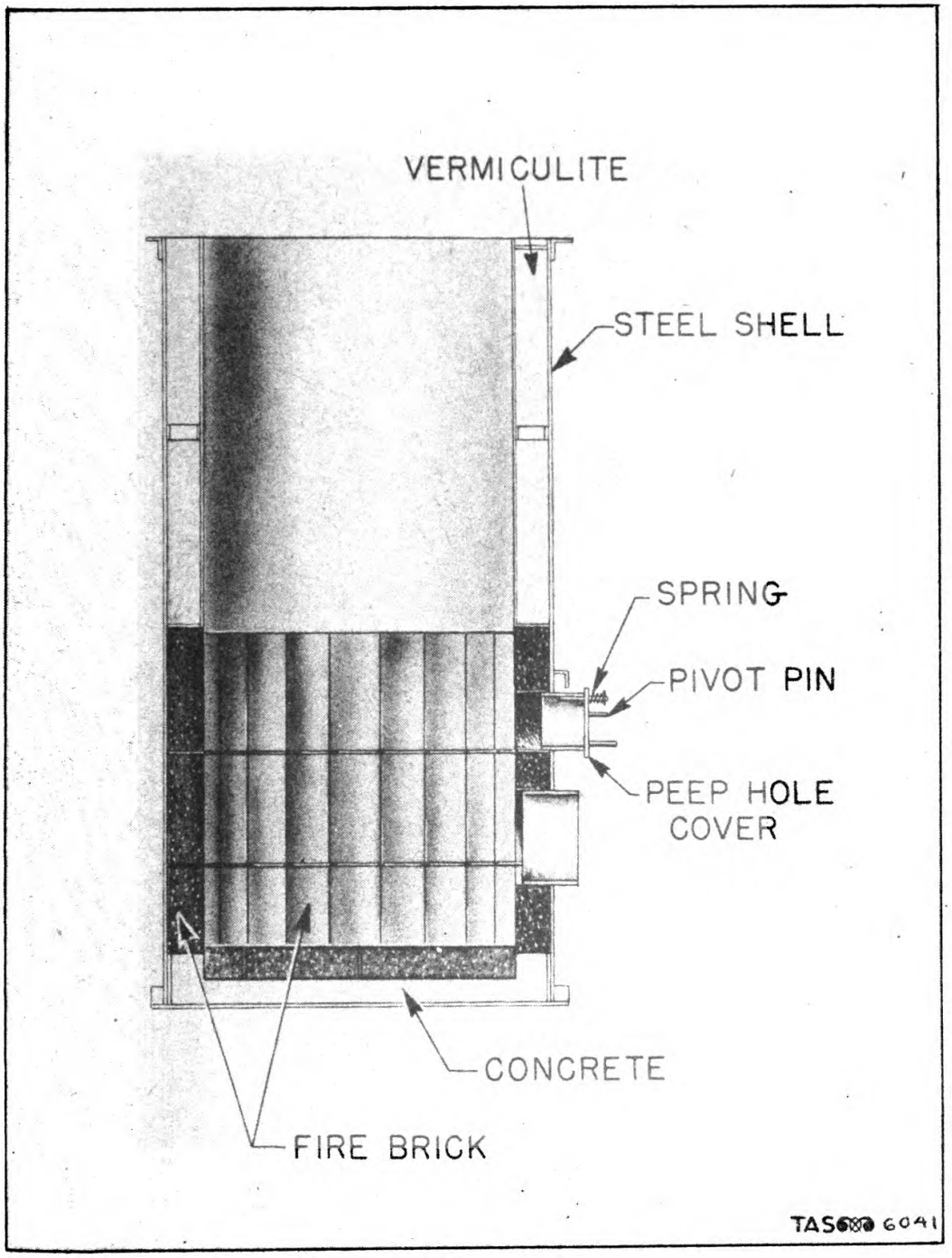

Fig. 41. Furnace Shell.

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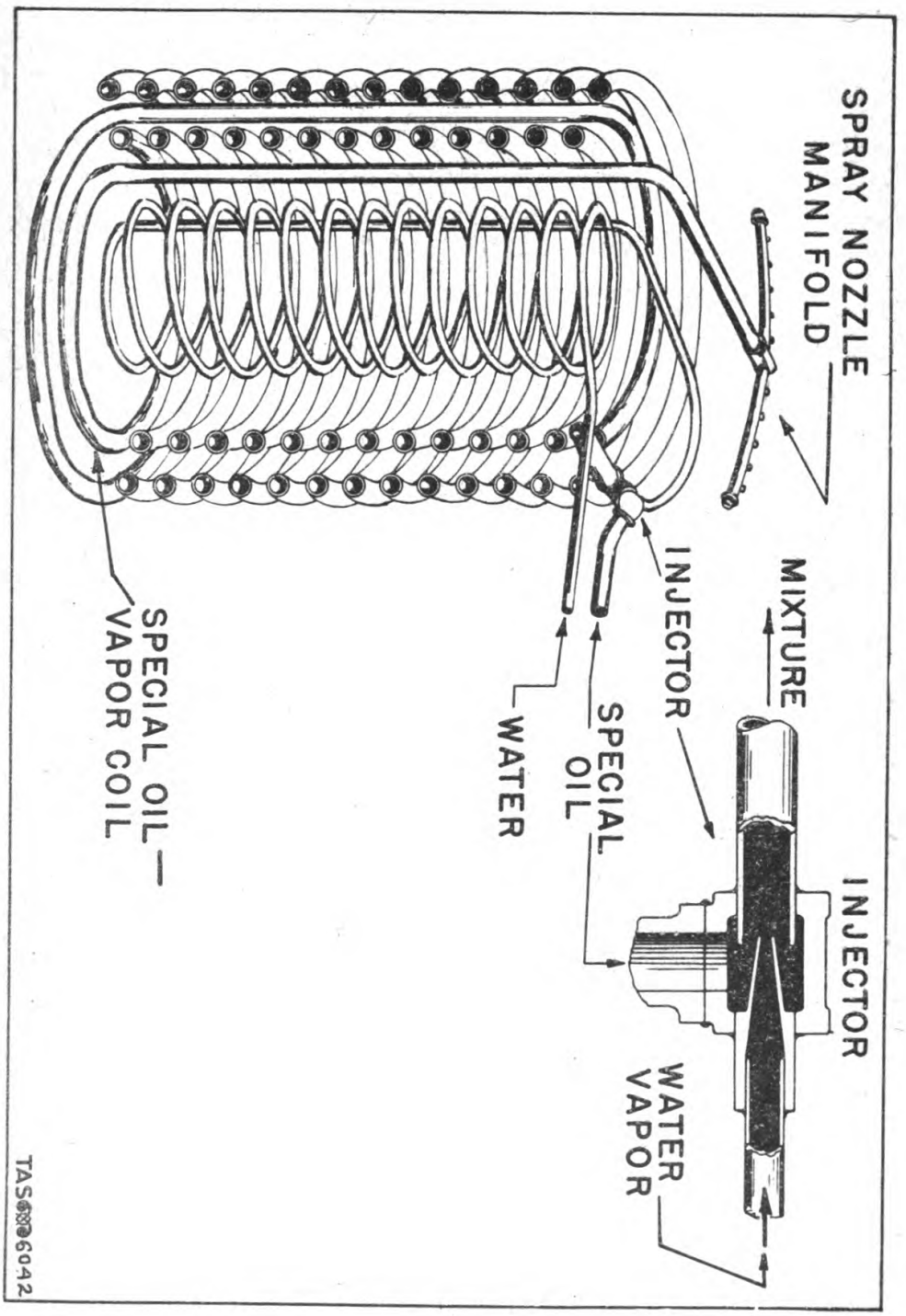

Fig. 42. Coil Assembly.

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(3) The injector, where cold special oil and hot vaporized water are mixed.

(4) The spray nozzle manifold. The manifold is attached to the furnace at the outlet of the coil assembly. It is a 3/4-inch pipe bent in an arc to approximate the contour of the furnace shell. In the arc are 10 spray nozzles, each having a bell-shaped hole of 3/16-inch diameter.

10. CONTROL SYSTEM. a. Definition. The control system consists of those devices directly involved in providing power for and controlling the operation of the mechanical smoke generator.

b. General. (1) The smoke generator is driven by a single-cylinder gasoline engine to which all pumps and the fuel oil burner are attached by means of a take-off shaft extending from the engine driveshaft. Operation of the engine is initiated by an electric starting motor which derives its power from a 6-volt battery Putting the engine in full operation not only starts all pumps and the burner fan, but also generates the spark between the two electrodes in the combustion head assembly of the burner. In other words, the rotation of the pumps and the burner fan and the production of flame in the firebox begin at one and the same time.

(2) The effective production of smoke requires that the flame in the firebox be of such intensity as to heat the coil assembly above to a minimum of 875 degrees Fahrenheit. Furthermove, successful operation of the machine requires that no special oil be permitted in the coil assembly until the coil has attained a certain minimum temperature. What this temperature is depends upon which of two operating procedures is being used. These operating procedures are described in paragraphs 13, 14, and 19.

(3) It requires from 3 to 6 minutes of operation

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for the smoke generator to "warm up" - that is, for the coil assembly to attain the minimum temperature at which it is safe to pass special oil into the coil. This is known as the "start-stop" period of operation. During this period the control lever on the generator control panel (fig. 44) must be kept in the "start-stop" position as labeled on the control panel. When the dial thermometer reaches the appropriate minimum, the control lever is pulled down to the "run" position. Lowering the control lever to the "run" position permits special oil to enter the coil assembly and initiates what is known as the "run" of the machine. Once the "run" is started, the temperature, as registered on the thermometer, rises rapidly to the 875 minimum required for the production of "good smoke." Throughout the run, the temperature must not be allowed to fall below 875 degrees Fahrenheit or to rise above 925 degrees Fahrenheit.

(4) For purposes of description the control system

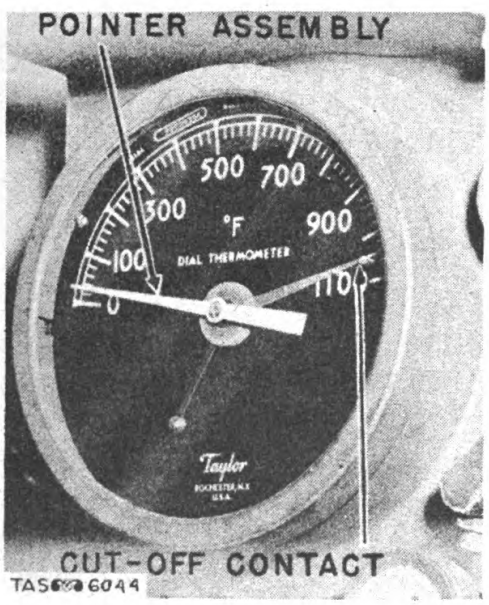

Fig. 43. Dial Thermometer.

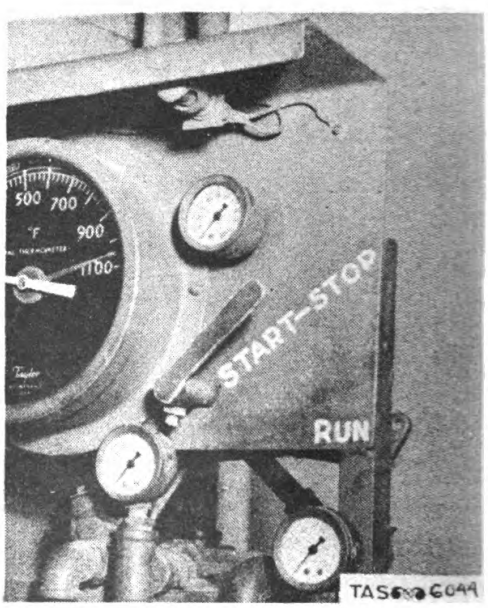

Fig. 44. Control Lever.

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may be divided into four subsidiary units. These are:

(a) Engine.

(b) Ignition.

(c) Generator control panel.

(d) Pressure gages.

The manner in which these subsidiary units work and a description of their chief components will be found in the immediately following paragraphs.

c. Engine. (1) The engine is a single-cylinder, 4-cycle, internal combustion engine, fueled with gasoline and started by an electric starting motor energized by a 6-volt battery. In operating principle it is similar to the engines used in standard automobiles. Readers unfamiliar with such engines are referred to TM 10-570.

(2) The engine, with some of its main components labeled, is shown in figure 45. It will be noted that there extends from the engine a take-off shaft. This shaft runs into the burner, first through a friction clutch and then through an outboard bearing, the driveshaft thrust collar of which is bolted to the burner fan housing. The friction clutch is automatic. It engages when the engine speed exceeds the idling speed and by so doing causes the take-off shaft to rotate. The outboard bearing supports the shaft. (See fig. 35.)

(3) To the take-off shaft the special oil pump, water pump, fuel oil pump, and burner fan are so attached that when the shaft rotates all four begin operation simultaneously. The special oil and water pumps are attached to the shaft by means of pulleys and belts, the fuel oil pump and burner fan by means of a flexible steel and rubber coupling at the burner end of the

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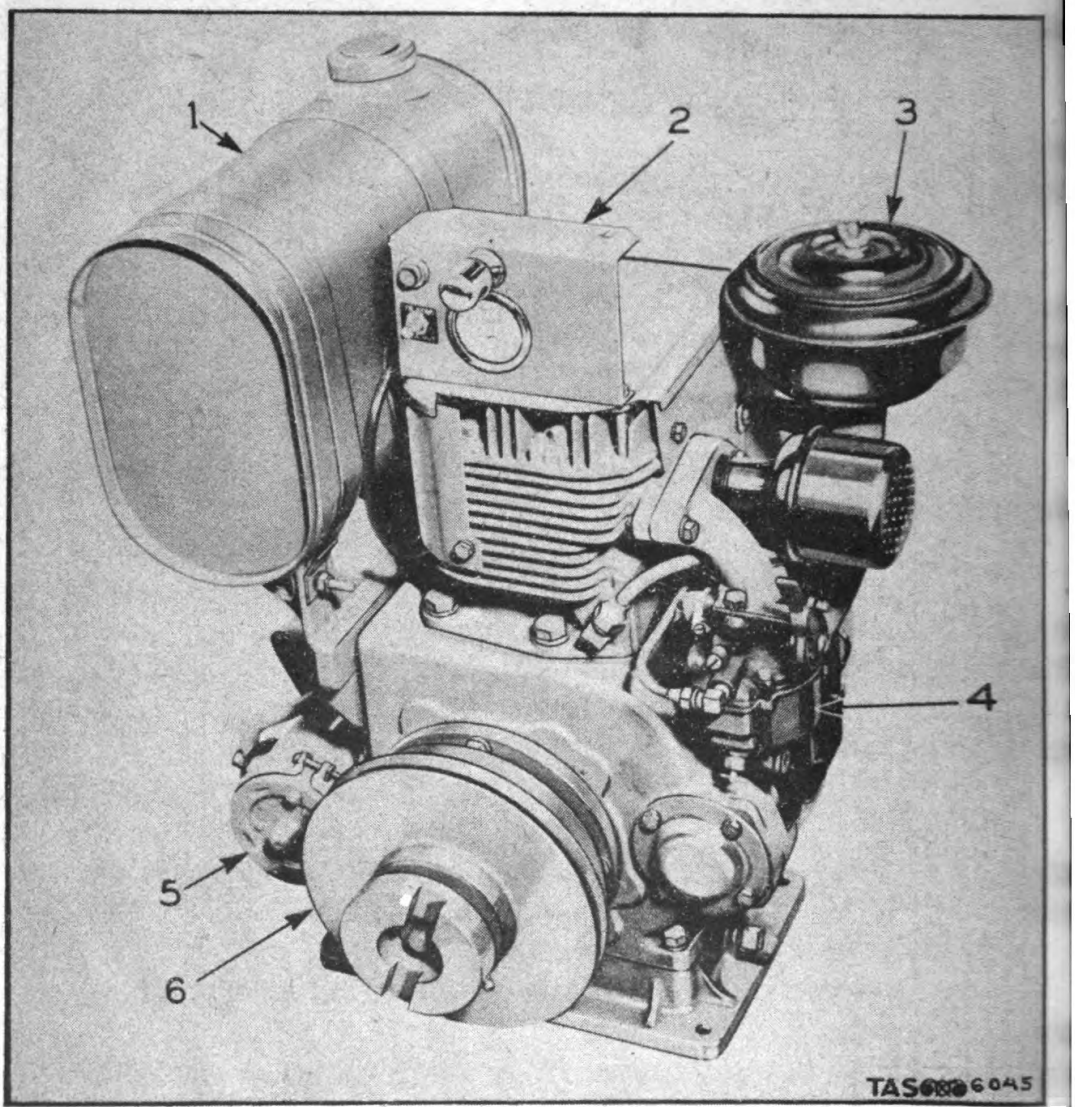

1. Gasoline tank.
2. Control panel.
3. Oil bath air cleaner.
4. Carbureter.
5. Starting motor.
6. Clutch.

Fig. 45. Engine.

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aft.

(4) The gasoline tank is attached directly to the en-
ıe. It holds 2-3/4 gallons which will operate the engine con-
ıuously for 8 hours.

(5) The engine is of the 4-cycle type, each of the
ır operations - suction, compression, expansion, and ex-
ust - requiring a complete stroke, or a total of two revolu-
ons of the crankshaft.

(6) The proper combustible mixture of gasoline and
r is furnished by the carburetor.

(7) The spark for ignition of the mixture is furnish-
. by a high tension magneto fitted with an impulse coupling.
or starting the engine and for generation of the engine spark,
6-volt battery, a generator, and an electric starting motor
quipped with a solenoid switch are provided.

(8) Lubrication is of the splash type. A plunger
ımp maintains the oil level in a trough under the connecting
od.

(9) Cooling is accomplished by a flow of air circu-
ted over the cylinder and heads by a combination fan-flywheel
ıcased in a sheet metal air shroud, the air being directed by
ıcts and baffle plates to insure uniform cooling of all parts.

(10) Engine speed is controlled by a centrifugal (fly-
ıll type) governor, which in turn is regulated by the throttle.
efore the engine is started, the governor holds the carburetor
ırottle valve wide open. But as soon as the engine is started
ıe governor regulates the speed at the predetermined number
: revolutions per minute. This is done through an adjusting
:rew and spring attached to the governor control lever, which
ı turn is connected by means of the governor control rod and

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the throttle stem and lever to the carburetor throttle valve. The governor spring is adjustable for various engine speeds - the greater the tension on the governor spring the higher the engine speed. Three holes are provided in the governor lever for the spring, and on the engines used on the smoke generator the spring should be hooked into the inner hole. (See fig. 47.)

(11) The starting of the engine is initiated by means of devices on the engine control panel. (See figs. 54 and 55.

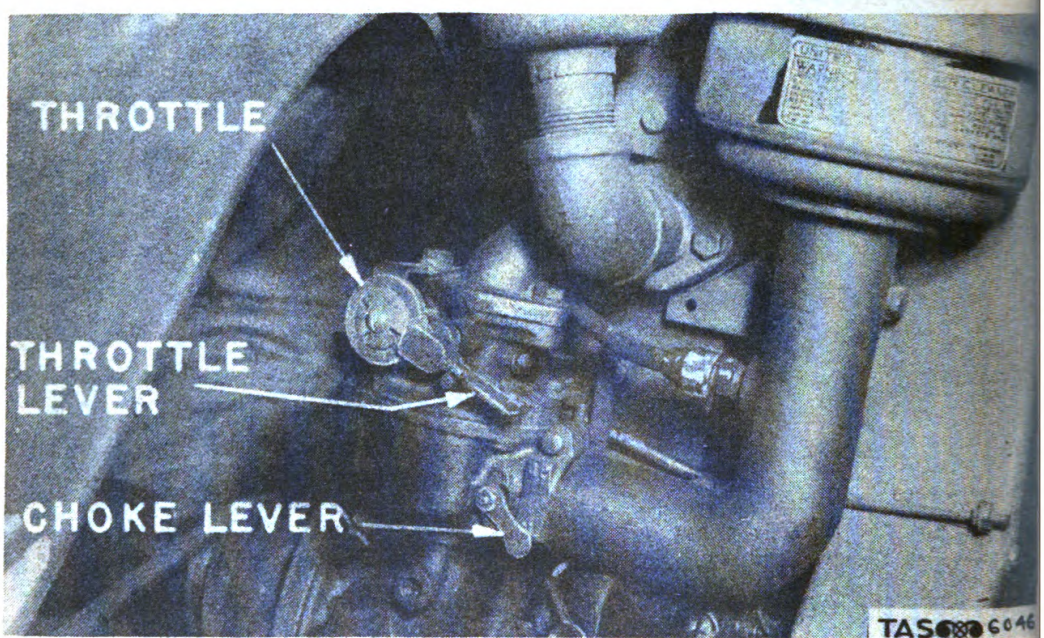

Fig. 46. Throttle and Choke.

The supplying of fuel to the engine and the movement of the control lever are controlled by the choke and throttle, which are located as shown in figure 46.

d. Ignition parts. (1) The ignition system of a transformer-ignition model smoke generator is diagrammed in figure 48. (See also fig. 49.) The ignition system of the magneto-

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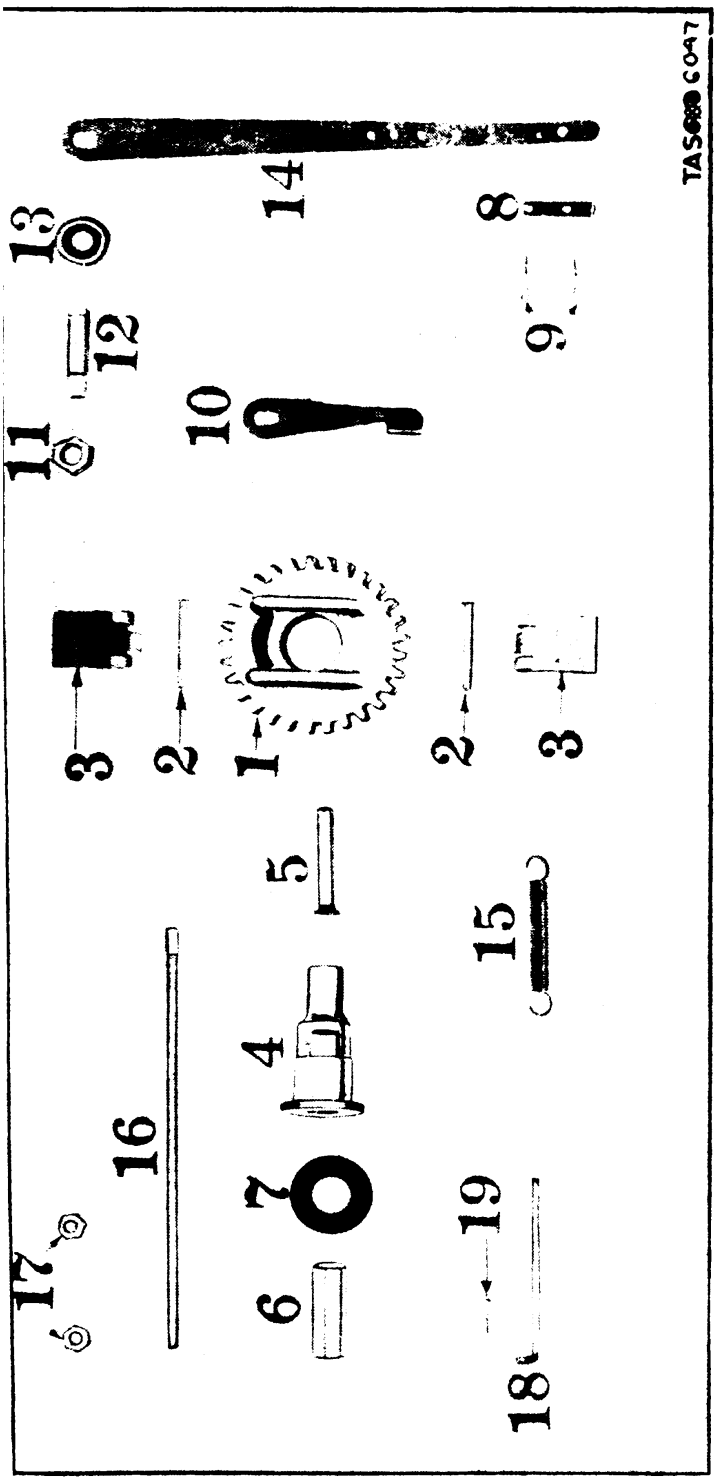

1. Gear.
2. Rivet.
3. Flyweight.
4. Gear sleeve.
5. Plunger.
6. Shaft.
7. Sleeve shim.
8. Gear stop pin.
9. Gear stop pin cotter pin.
10. Inner lever.
11. Nut.
12. Lever fulcrum pin.
13. Fulcrum pin oil seal.
14. Control lever.
15. Spring.
16. Adjusting screw.
17. Nut.
18. Control rod.
19. Control rod cotter pin.

Fig. 47. Governor.

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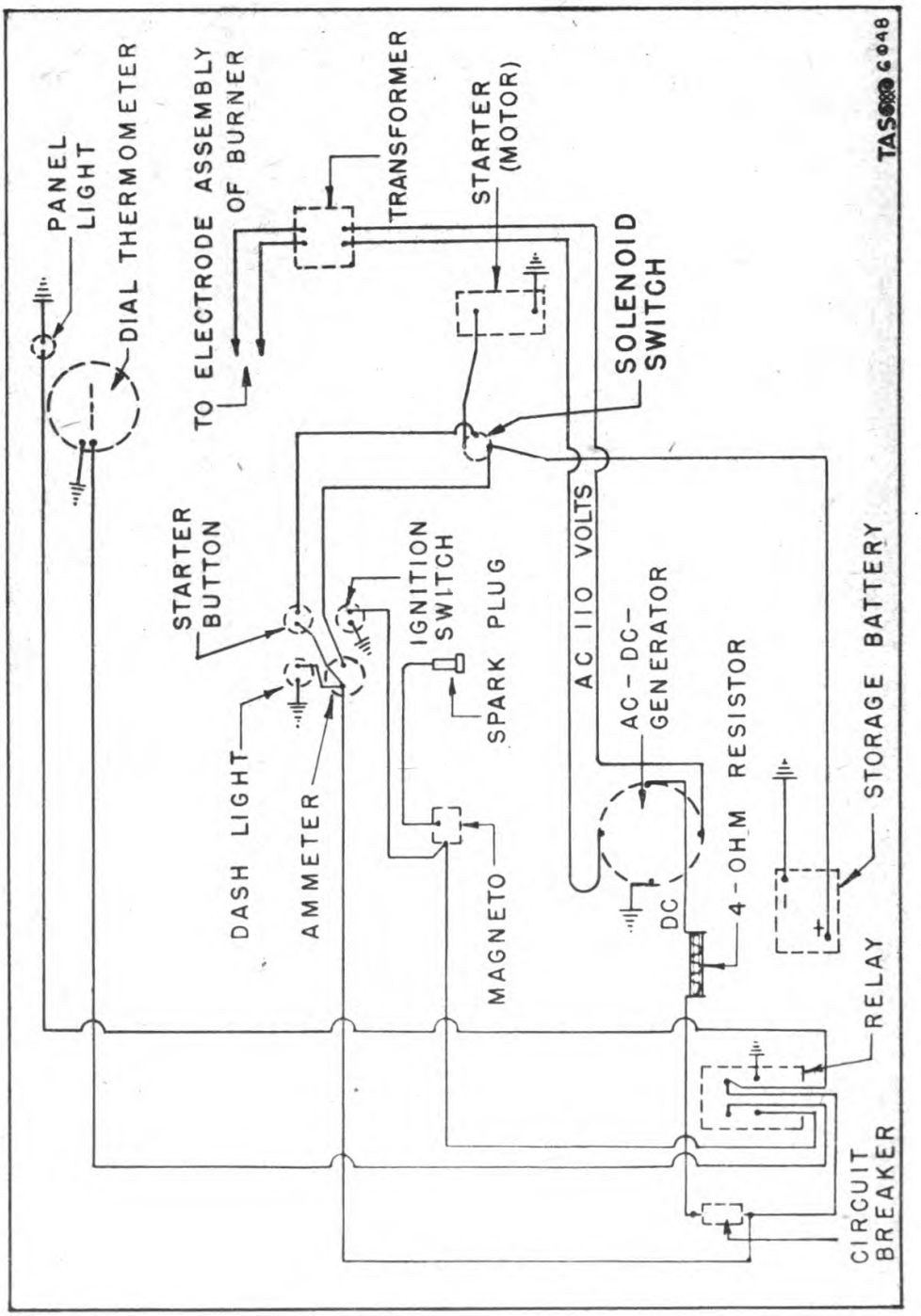

Fig. 48. Ignition System on Transformer-ignition Model.

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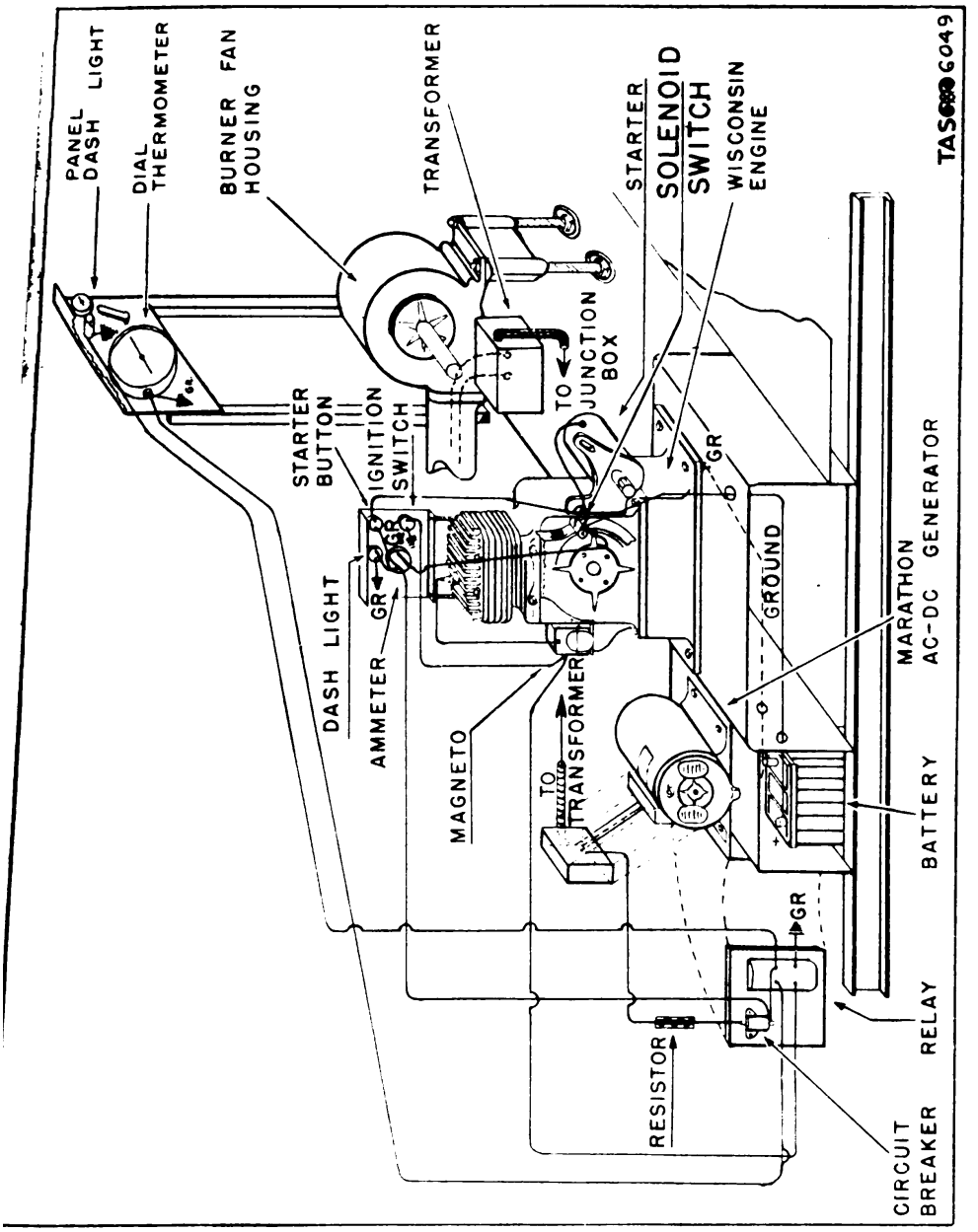

Fig. 49. Diagram of Wiring for Transformer-ignition Model.

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ignition model generator is similar. The differences between the two are described in the immediately following paragraphs.

(2) The ignition system on both transformer and magneto-ignition generators is set in operation by means of the starter button and the ignition switch, these being located on the engine control panel. The ammeter, also located on the engine control panel, registers amperage of the battery and shows whether the battery is charging or discharging. A dash light on the panel facilitates night operations.

(3) Every smoke generator - whether a transformer-ignition model or a magneto-ignition model - is equipped with an engine generator, a 6-volt battery, a starting motor equipped with a solenoid switch, a reverse current relay, an A-B relay for the thermometer cut-out contact, a circuit breaker, and a high tension engine magneto.

(4) Transformer-ignition models are equipped also with a transformer, the function of which is to provide the spark for igniting the burner mixture. On transformer-ignition models the engine generator is designed to furnish 110 volts of alternating current to energize the transformer and from 6 to 8 volts of direct current for charging the battery.

(5) On magneto-ignition models the spark for igniting the burner mixture is supplied not by a transformer but by a second magneto, which is belted to the engine take-off shaft and which is known as the burner magneto. The burner magneto is not energized by the engine generator; it is driven by a belt directly from the engine take-off. On magneto-ignition models the engine generator has only one function: it furnishes from 6 to 8 volts of direct current for charging the battery.

(6) The circuit breaker is a regulating and protective device. It automatically closes the circuit between engine

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generator and battery when the generator voltage rises above that of the battery. It automatically opens the circuit when the generator voltage falls below that of the battery.

(7) The function of the relay is to protect the coils of the smoke generator from overheating. It functions in connection with the cut-off contact on the dial thermometer. Attached to the underside of the pointer on the dial thermometer is a thin rod known as the "catwhisker." When the dial pointer reaches the unsafe temperature level of 1,050 degrees Fahrenheit, the "catwhisker," which travels with the pointer, makes contact with the cut-off contact. This magnetizes a spark coil in the relay in such a way as to break the ignition circuit and completely shut down the operation of the generator. (See also par. 10 e following.)

e. Ignition wiring for transformer-ignition model. (1) The wiring system of a transformer-ignition model generator is diagrammed in figures 48 and 49.

(2) A conductor runs from the 6-volt battery, the negative pole of which is grounded to the frame of the smoke generator, to the solenoid switch. (See fig. 50.) Another conductor leads from the solenoid switch to the starting motor. (See fig. 120.)

(3) Another conductor runs from the solenoid switch to the starter button on the engine control panel and from thence to the ammeter on the panel. A third conductor from the solenoid switch leads directly to the ammeter

(4) A conductor leads from the ammeter to the circuit breaker. (Fig. 51.) The circuit breaker normally is open. It is closed by an electro-magnet energized by the engine generator when the engine speed reaches approximately 1,300 revolutions per minute. Without this element the battery would

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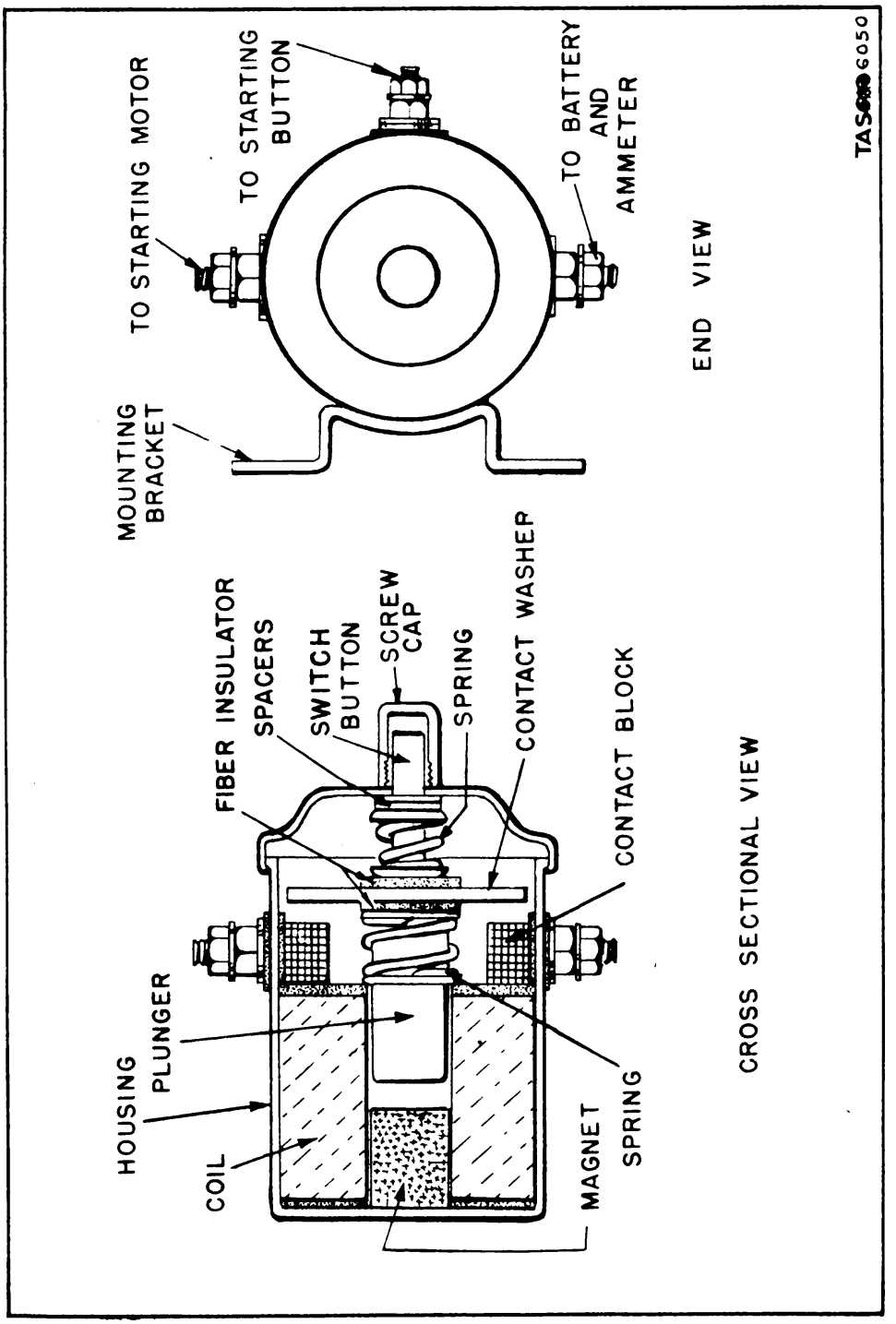

Fig. 50. Solenoid Switch.

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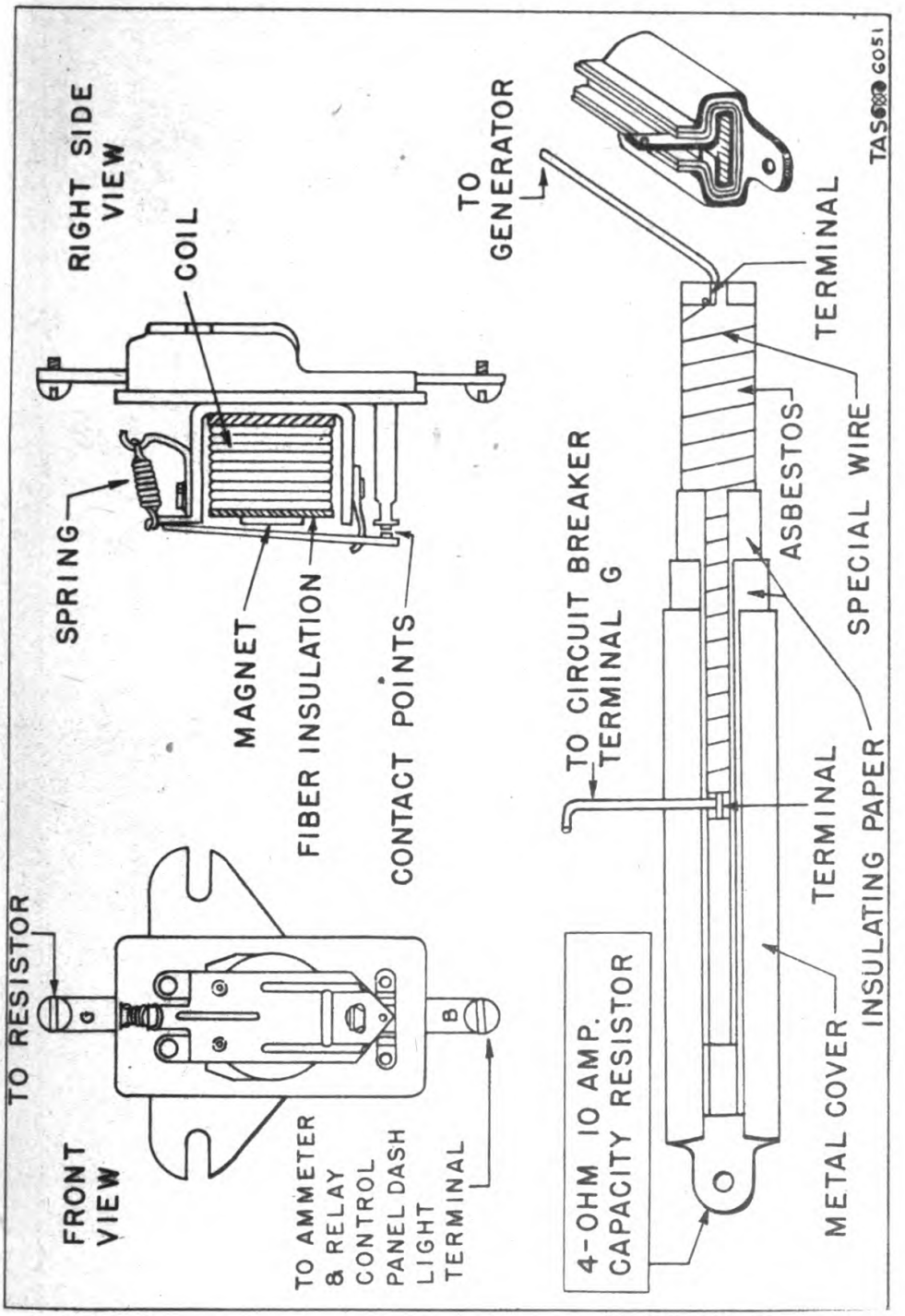

Fig. 51. Circuit Breaker and Resistor.

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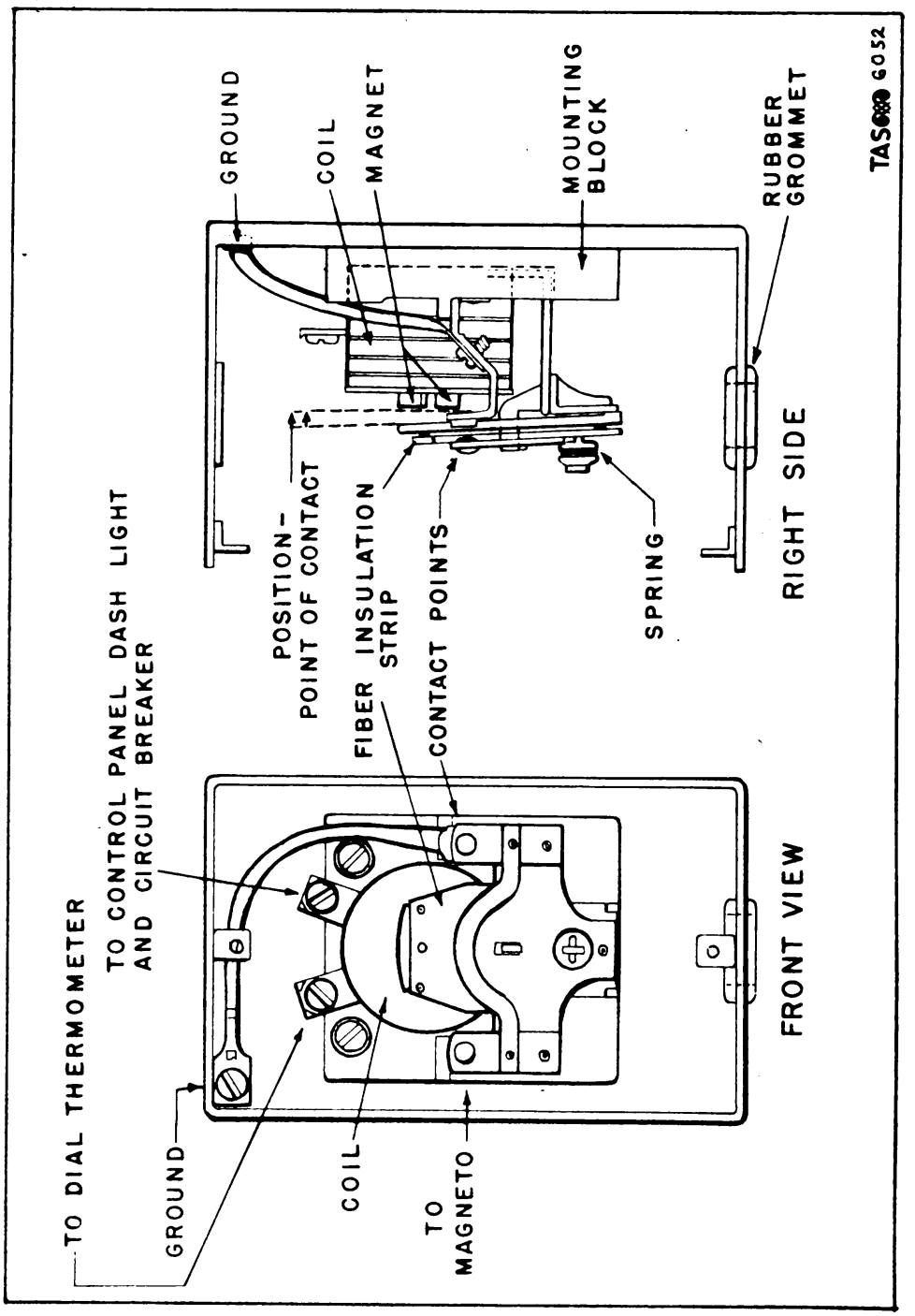

Fig. 52. Relay.

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quickly run down.

(5) From the circuit breaker one conductor leads through a 4-ohm resistor to the engine generator, from which two conductors lead through a step-up transformer (110 to 10,000 volts) to the electrodes in the combustion head assembly of the burner.

(6) Another conductor from the circuit breaker leads to the relay. (Fig. 52.)

(7) From the relay one conductor leads to the dial thermometer and ground, and another through the generator control panel dash light to a ground on the generator frame.

(8) Still another conductor from the relay leads to the engine magneto and thence to the engine spark plug.

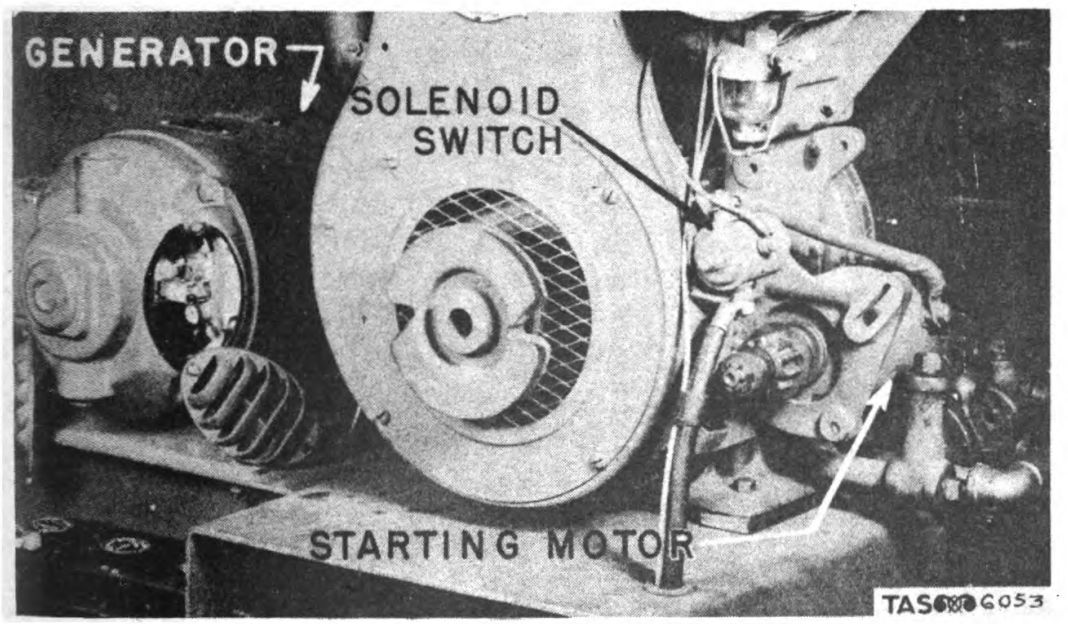

Fig. 53. Ignition Parts, Transformer-ignition Model.

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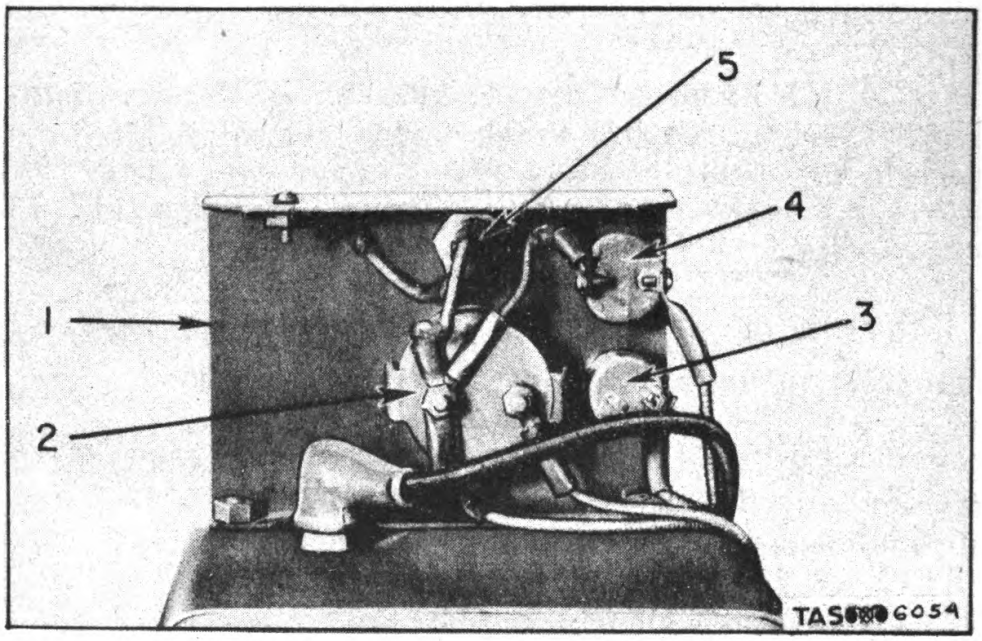

1. Panel.
2. Ammeter assembly.
3. Switch assembly - grounding assembly.
4. Switch assembly - magneto.
5. Dash lamp.

Fig. 54. Engine Control Panel, Rear View.

(9) The ignition switch on the engine control panel also is connected through the engine magneto to the spark plug.

(10) When the ignition switch is turned on and the starter button depressed, direct current flows from the battery through the solenoid switch and starting motor, thus starting the engine. When the engine reaches 1,300 revolutions per minute the automatic clutch is engaged, the pumps begin to function, and alternating current flows from the engine generator through the transformer to the electrodes.

(11) The spark plug is energized by the engine magneto.

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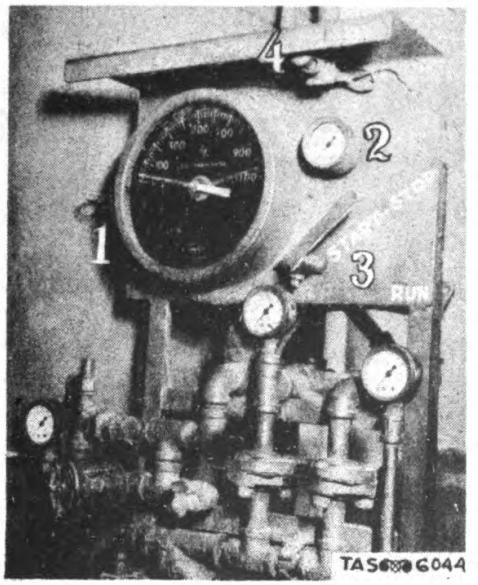
(12) As previously explained, the engine generator recharges the battery through its direct current output. This output - 15 to 18 volts - is reduced by the 4-ohm resistor to about 6 to 8 volts flowing through the circuit breaker and ammeter to the battery.

(13) When the dial thermometer pointer reaches 1,050



1. Dial thermometer.
2. Spray nozzle pressure gage.
3. Control lever.
4. Dash light.

Fig. 55. Generator Control Panel, Front View.

degrees Fahrenheit and the "catwhisker" makes contact with the cut-off contact and closes the circuit, the relay is actuated and the engine magneto ceases to function, with the result that no spark is produced.

(14) The solenoid switch operates as follows: when

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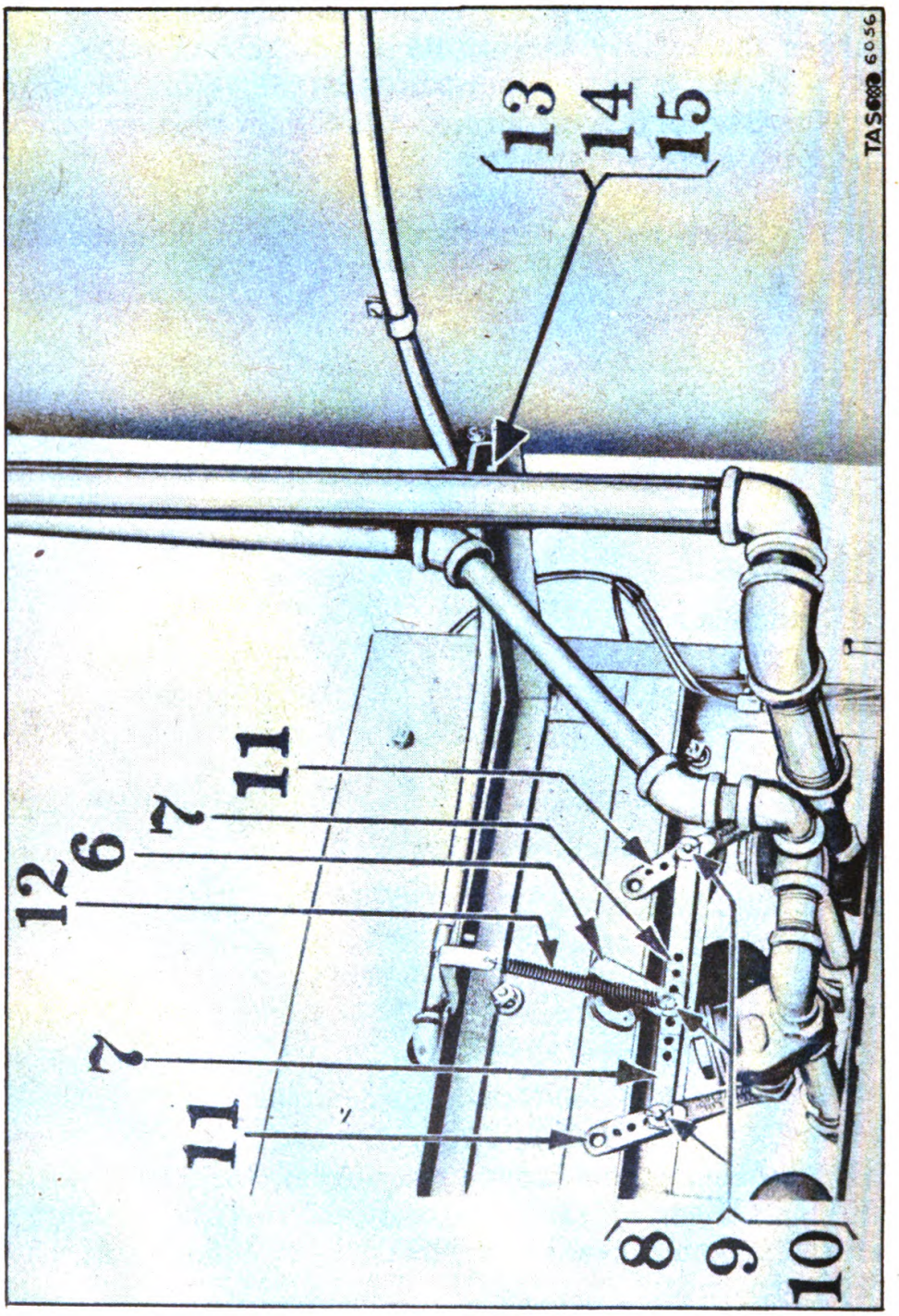

Fig 56 Generator Control Panel, Rear View. (See opp. page.)

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the starter button is depressed a magnet is energized, drawing in the plunger and closing the circuit between battery and starting motor.

f. Generator control panel. (1) A front view of the generator control panel is shown in figure 56. On this panel are the dial thermometer, the spray nozzle pressure gage, and the generator control lever. There is no spray nozzle pressure gage on some machines. Where this gage has been eliminated, the spray nozzle pressure gage piping has been removed and a pipe plug put in the tapped hole on the spray nozzle manifold.

(2) Function of the thermometer is to register the temperature of the special oil-vapor mixture - that is, of the "smoke" - at the spray nozzles in the spray nozzle manifold. The dial is connected to the spray nozzle manifold by means of a mercury-filled tube which runs from the dial to an instrument bulb embedded in the three pipe nipples at the center of the manifold. During the run of the generator the operating range is 875-925 degrees Fahrenheit, and the dial reading should be kept within this bracket.

Nomenclature for Figure 56.

6. Control lever.	11. Quick-opening valve lever.
7. Connecting links.	12. Spring.
8. Link pin.	13. Cap screw.
9. Cotter pin.	14. Lock washer.
10. Washer.	15. Nut.

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(3) The spray nozzle pressure gage registers the pressure of the special oil-vapor mixture at the spray nozzles, being attached to the latter by an iron piping.

(4) The control lever is attached to both the special oil quick-opening valve and the water quick-opening valve by means of a lever and two handles linked together and supported

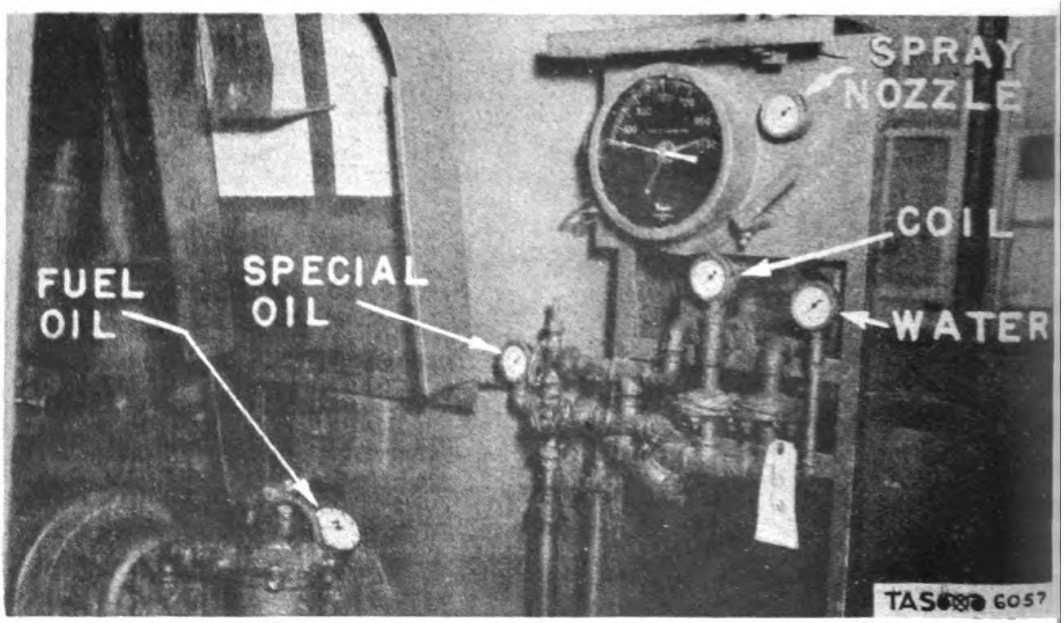

Fig. 57. Pressure Gages.

by a spring on the rear of the generator control panel. (See fig. 57.) By means of this lever attachment the control lever operates both valves at one and the same time. When placed at "start-stop," the lever OPENS the water quick-opening valve, thus letting water pass through BOTH water orifices (A and B), and CLOSES the special oil quick-opening valve, thus preventing the passage of special oil to the coil assembly and forcing it instead to return to the special oil supply tank by way of the special oil return line. When placed at "run," the control lever CLOSES the water quick-opening valve, thus closing water orifice B, and OPENS the special oil quick-opening valve to permit

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e passage of special oil to the coil assembly. When the con-
ol lever is at "start-stop" approximately 12 gallons of water
ter the coil assembly per hour, each water orifice being de-
gned to pass 6 gallons; no special oil enters the assembly, the
ick-opening valve on the oil manifold being closed When the
ntrol lever is lowered to "run" the closing of water orifice B
ts the flow of water into the coil to 6 gallons per hour, while
e opening of the special oil quick-opening valve permits from
to 100 gallons of special oil to pass into the coil per hour.

(5) A small dashlight on the generator control panel
cilitates observation of the thermometer during night opera-
ons.

g. Pressure gages. (See fig. 58.) In addition to the
ray nozzle pressure gage on some generator control panels,
e generator is equipped with four other pressure gages. The
el oil pressure gage, located on the burner fan housing, shows
e pressure of oil passing through the outer discharge tubing
to the burner. A special oil pressure gage, located on the
anifold, shows the pressure of special oil prior to its passage
rough the manifold valves. A water pressure gage, located
an extension on the outer side of the water manifold, shows
e pressure of water just prior to its passage through the ori-
ces. A coil pressure gage, located on the water manifold just
ove orifice A, shows the pressure of water passing into the
il assembly.

11. ACCESSORIES. a. Tool box. A tool box is permanent-
attached to one of the lower floor plates on the frame of every
nerator. It should contain:

1 - Manual on operative and maintenance.
1 - Special key for adjusting the fixed needle valve.
(This key is sometimes found wired to the special
oil manifold.)

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1 - Pliers, 6".
1 - Screwdriver, 7".
1 - Crescent-type adjustable wrench, approximately 8' long.
1 - Combination wrench for opening barrels.
1 - Hydraulic grease gun, 3-oz.
1 - Burner atomizing nozzle.
1 - Spray nozzle.
1 - Oil can.
1 - Ball peen hammer.
2 - Open-end wrenches, 1/2" and 19/32".
1 - Electrode spacing gage.
1 - Padlock and keys.

b. Other accessories. The generator is equipped also with one funnel, for which a permanent support is supplied on the right side floor plate of the frame; one 1-inch x 1-1/4-inch x 5-foot special oil level gage, which is graduated in 1/8-inch increments and which is usually stored on top of the supply tanks; and a key for the fuel oil shut-off valve, which usually is attached to the piping near the valve.

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SECTION III

OPERATION

	Paragraph
General	12
Warming up generator in "Start-Stop" position	13
Running generator in "Run" position	14
Shutting down and restarting	15
Test-running the generator	16
Nursing generator during run	17
Starting the engine	18
Adapting generator to use approved operating procedure	19

12. GENERAL. a. Procedures. The steps which must be taken to operate the mechanical smoke generator effectively are described in paragraphs 13 and 14. By making certain adjustments on the machine and by utilizing an improved operating procedure, the time required to produce smoke can be materially shortened. These adjustments together with the improved operating procedure are described in paragraph 19.

b. Chief difference. The chief difference between the operating procedure described in paragraphs 13 and 14 and the improved procedure described in paragraph 19 has to do with the point at which it is safe to shift the control lever from "start-stop" to "run" and permit special oil to enter the coil assembly. When the machine is being operated as described in paragraphs 13 and 14 the control lever must not be shifted to "run" until the dial thermometer reads 700 degrees Fahrenheit, except in very cold climates where it should be shifted to "run" when the thermometer reads 500 degrees Fahrenheit. When the improved operating procedure is used the control lever must always be shifted to "run" so soon as the thermometer reaches 500 degrees Fahrenheit.

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c. Policy. It is advocated that at installations where smoke generators have been in use for some time, the adjustments described in paragraph 19 be made on all machines and the improved procedure be employed. Smoke generator companies receiving new machines should adjust them immediately and use the improved operating procedure.

13. WARMING UP GENERATOR IN "START-STOP" POSITION. a. First operating step. The first step in operating the generator is to warm it up in order to heat the coil assembly to the point where special oil may be passed into it safely.

b. Procedure. To warm up the generator in the "start-stop" position, take the following steps in the order listed:

(1) Fill the special oil supply tank to capacity.

(2) Fill the fuel oil supply tank to capacity.

(3) Fill the water supply tank to capacity.

(4) Fill the gasoline tank to capacity.

(5) Make certain that the special oil hand-regulating valve is CLOSED. (See fig. 58.)

(6) MAKE CERTAIN THAT THE CONTROL LEVER ON THE GENERATOR CONTROL PANEL IS AT "START-STOP."

(7) OPEN ALL THREE GATE VALVES. (To open a gate valve, FACE the wheel and turn it toward the left - that is, always turn it counter-clockwise. On some generators this wheel is reached through a hole in the floor plate behind the supply tank. (See fig. 59.) On others the gate valve wheels extend above the floor plate.)

(8) Place throttle in idle position. (To do this, push

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Fig. 58. Closing Special Oil Hand-regulating Valve.

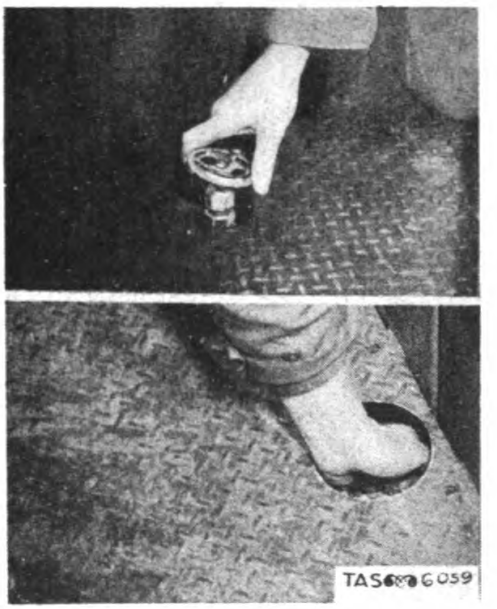

Fig. 59. Opening Gate Valves.

it up a trifle, but not so far as completely to release the throttle lever on which it rests - only far enough to permit the engine to idle.) (See fig. 60.)

(9) Push the choke down to the "CL" (closed) position. (See fig. 61.) The choke will release automatically when the engine starts.

(10) Open the carburetor feed valve on the glass strainer under the gasoline tank. (See fig. 62.)

(11) Turn on the ignition by PUSHING IN the ignition switch lever on the engine control panel.

(12) Start the engine by DEPRESSING the starter button on the engine control panel. Should the battery be dead, start

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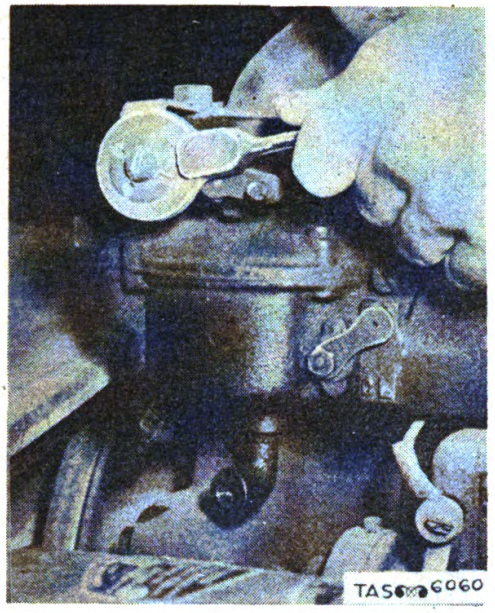

Fig. 60. Placing Throttle in Idle Position.

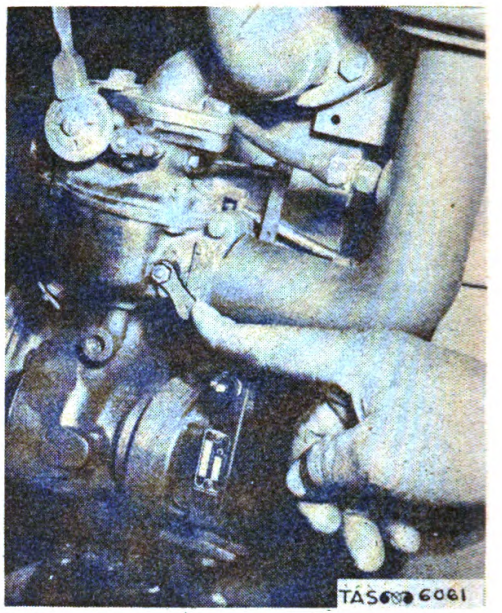

Fig. 61. Pushing Choke to "CL" Position.

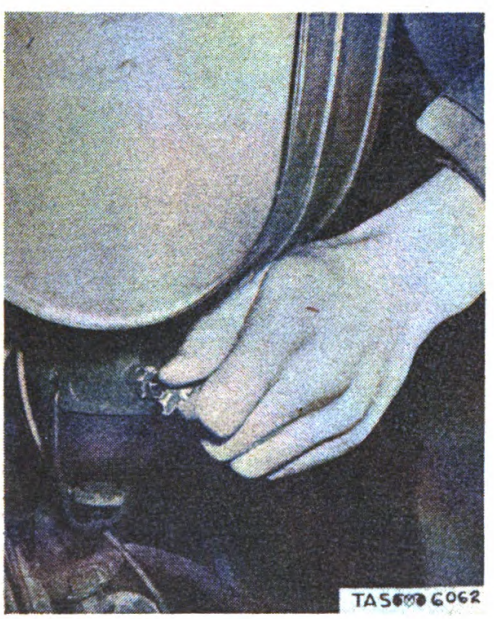

Fig. 62. Opening Carburetor Feed Valve.

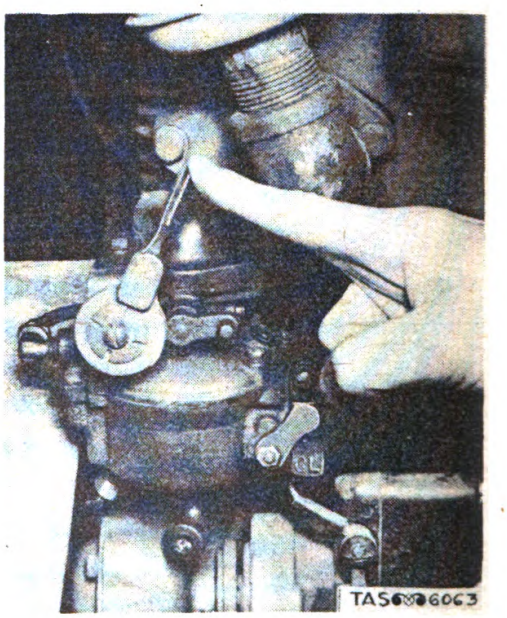

Fig. 63. Placing Throttle in Run Position.

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the engine with a rope or hand-crank. (See par. 18.)

(13) When the engine is warmed up and is running smoothly, place the throttle in the run position - that is, push the throttle up so as to release completely the throttle lever. (See fig. 63.)

(14) Open the peep-hole and look in to make certain that the fuel oil-air mixture is burning in the firebox.

(15) WATCH THE DIAL THERMOMETER ON THE GENERATOR CONTROL PANEL. (From a cold start it should rise to 700 degrees Fahrenheit in about 6 minutes.)

14. RUNNING GENERATOR IN "RUN" POSITION. a. Full operation. The second step in operating the generator is to pull the control lever down to the "run" position in order to permit special oil to enter the coil assembly for the purpose of mixing with water to make smoke. This puts the generator in full operation, and this phase of the operation is known as the "run." The run must not be started until the dial thermometer registers 700 (500 in extreme cold) degrees Fahrenheit.

b. Procedure. To run the generator, take the following steps:

(1) Pull the control lever down to the "run" position.

(2) Watch the dial thermometer. When it reaches 820 degrees Fahrenheit increase the flow of special oil into the coil assembly by opening the special oil hand-regulating valve. To open this valve, turn its hand-wheel to the left (i.e., toward the engine) about one-fourth turn. To repeat: NEVER OPEN THE SPECIAL OIL HAND-REGULATING VALVE UNTIL THE DIAL THERMOMETER REGISTERS AT LEAST 820 DEGREES FAHRENHEIT.

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(3) The dial thermometer reading should now rise rapidly to the operating range of 875-925 degrees Fahrenheit. Temperature should be kept between these two figures throughout the run. As a rule this is accomplished by proper manipulation of the special oil hand-regulating valve. (See par. 17.)

15. SHUTTING DOWN AND RESTARTING. a. Purpose. Adjustments and repairs called for from time to time during the warming up or running of the generator frequently demand that it be shut down and restarted.

b. Shutting down procedure. To shut down the generator, take the following steps:

(1) PULL OUT the ignition switch lever on the engine control panel. (This stops operation of the machine.)

(2) Push the throttle down as far as it will go.

(3) Close the special oil hand-regulating valve. IF SHUT DOWN IS TEMPORARY, NO FURTHER STEPS NEED BE TAKEN.

(4) If the generator is to be shut down for some time, close the carburetor feed valve and all three gate valves. (To close a gate valve, always face the wheel and turn it toward the right - that is, always turn it clockwise.)

c. Restarting procedure. The steps to be taken in restarting the generator depend on what temperature the dial thermometer is registering.

(1) If the thermometer shows a reading of less than 700 degrees Fahrenheit in normal weather or less than 500 in extreme cold, the generator must be warmed up as described in paragraph 13 and then run as described in paragraph 14.

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(2) If the thermometer shows a reading between 700 and 820 degrees Fahrenheit (or between 500 and 820 in extreme cold) proceed as follows:

(a) Be sure that all gate valves are open.

(b) Be sure that the carburetor feed valve is open.

(c) Be sure that the control lever is at "run."

(d) Be sure that the special oil hand-regulating valve is closed.

(e) Start the engine with the throttle in the idle position in order to release the throttle lever completely.

(f) When the thermometer reaches 820 degrees Fahrenheit, open the special oil hand-regulating valve.

(3) If the thermometer registers 820 degrees Fahrenheit or above, proceed as follows:

(a) Be sure that all gate valves are open.

(b) Be sure that the carburetor feed valve is open

(c) Be sure that the control lever is at "run."

(d) Be sure that the special oil hand-regulating valve is open about one-fourth turn.

(e) Start the engine with the throttle in the idle position.

16. TEST-RUNNING THE GENERATOR. a. Purpose. To

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make repairs and adjustment, and to check the causes of mechanical difficulties, it is sometimes necessary to operate the smoke generator engine and the pumps without lighting the burner and without pumping special oil into the coil assembly.

b. Procedure. Such test-running is accomplished as follows:

(1) Close the shut-off valve at the entrance to the burner air tube on the outer fuel oil discharge tubing. (See fig. 64.)

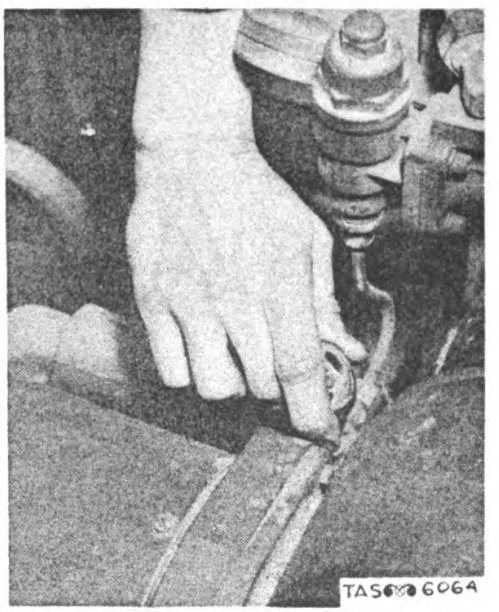

Fig. 64. Closing the Shut-off Valve.

On some generators this valve is equipped with a handle for turning purposes; on others with a key. Closing the shut-off prevents fuel oil from flowing into the burner and thus prevents the production of flame in the firebox.

(2) Be sure that the control lever is in the "start-

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stop" position. LEAVE IT THERE to prevent passage of special oil into the coil assembly.

(3) Take all steps prescribed for warming up the generator in paragraph 13 up through sub-paragraph b (12). The water will flow through the coil assembly and escape - as water - through the spray nozzle manifold. Special oil and fuel oil will run through the special oil and fuel oil pumps, thus preventing damage to the pumps. These fuels will then by-pass to their supply tanks by way of the special oil and fuel oil return lines.

17. NURSING GENERATOR DURING RUN. a. General. While the smoke generator is operating in the "run" position and producing smoke, the operator has a fourfold job:

(1) He must make certain that the generator is producing good smoke.

(2) He must make regular checks of the liquid levels in the fuel supply and gasoline tanks.

(3) He must see that the dial thermometer reading does not fall below 875 degrees Fahrenheit and does not rise above 925 degrees.

(4) He must make necessary service tests, adjustments, and repairs.

b. Good and bad smoke. (1) When in operation in the "run" position the mechanical smoke generator does one of two things. It produces good smoke or it produces bad smoke.

(2) When the machine is producing good smoke the jet of smoke coming out of each of the 10 spray nozzles on the spray nozzle manifold will look like the jet diagrammed in fig-

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ure 65. For about 1/2-inch from the nozzle the jet will be transparent. For the next 1 or 1-1/2-inch it will be clear in the middle and fuzzy at the edges. From there on it will be dense white smoke. As a rule the production of good smoke means that all parts of the generator are working correctly.

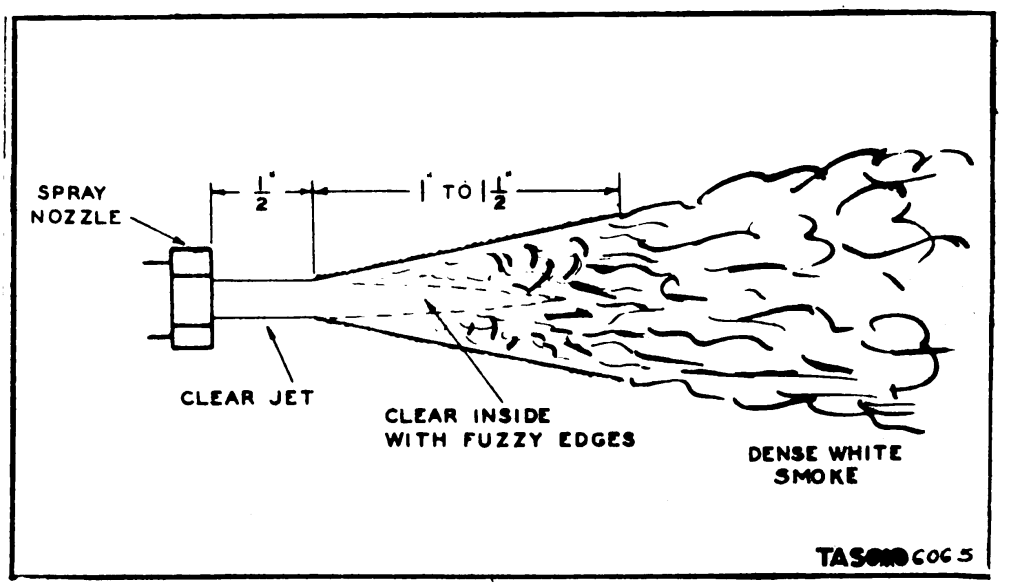

Fig. 65. Good Smoke.

(3) Bad smoke is any smoke which does not conform to the description of good smoke given above. If the jet is black or bluish, if there is no 1/2-inch of transparent smoke at the nozzle, if a fine mist of oil droplets comes out - these or any other abnormal factors mean that the generator is producing bad smoke.

(4) The appearance of bad smoke means that the operator must make some adjustment or repair some part of the generator. The possible causes of bad smoke, the checks to be made to discover these causes, and possible remedies are discussed in Section V.

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(5) Bad smoke always means trouble and must always be checked and corrected. Other possible indications of trouble - overheating of the burner, noise in the engine generator, etc., - these, their possible causes, checks, and remedies also are discussed in Section V.

c. Special oil. (1) A full special oil supply tank will operate the generator about 1 hour. To insure uninterrupted operation, however, the special oil supply tank must be refilled at least every 45 minutes while the machine is operating.

(2) The rate at which special oil is used is not always the same. Sometimes the machine uses as much as 110 gallons an hour, sometimes as little as 90. A check should be made shortly after the control lever is put in the "run" position so that the tank can be refilled before oil from the bottom one-fourth of the tank gets into the special oil piping. Rechecks should be made every 20 or 25 minutes.

Depth of oil used in 3 minutes	Gallons per hour corresponding
2 inches	76
2-1/8 "	81
2-1/4 "	85
2-3/8 "	90
2-1/2 "	95
2-5/8 "	100
2-3/4 "	104
2-7/8 "	109
3 "	114

Fig. 66. Special Oil Consumption Chart.

(3) In checking the rate at which the machine is using special oil, do not rely upon the gage at the top of the special oil supply tank. Use a clean special oil level gage (par. 11 b), a watch with a second hand, and the special oil consumption chart shown in figure 66. The procedure is this: note the posi-

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tion of the second hand on the watch and at the same time insert a clean special oil level gage in the tank so that it touches the bottom. (See fig. 67.) Withdraw the gage and measure the depth of oil registered on it. Wait exactly 3 minutes. Again insert the gage and measure the depth of oil. The difference between the depth of oil the first time the gage was inserted and the second gives the number of inches of oil used in 3 minutes. To find how many gallons per hour the generator is using, refer to the special oil consumption chart. If, for example, the oil falls 2 inches in 3 minutes, the generator is using only 76 gallons an hour; if it falls 3 inches the generator is using 114 gallons. It is recommended that this special oil consumption chart be pasted on some sheltered section of the smoke generator.

d. Water and fuel oil. The water and fuel oil supply tanks should be refilled at least every 8 operating hours. The best rule is to fill all tanks to capacity every time operation of the generator is planned.

e. Gasoline. As a precaution against possible waste, the carburetor feed valve should be kept closed when the generator is not in operation. The tank must be refilled at least every 6 operating hours.

f. Dial thermometer. Under no circumstances during the run of the generator must the dial thermometer be allowed to register less than 875 degrees Fahrenheit or more than 925 degrees. Whenever it goes below or above, adjustments must be made no matter how well the generator is operating. Normally the dial thermometer reading can be corrected by means of the special oil hand-regulating valve. When the thermometer reading falls below 875 degrees Fahrenheit it indicates that too much special oil is reaching the coil assembly. Remedy this by closing the special oil hand-regulating valve. When the thermometer reading goes above 925 degrees Fahrenheit it indicates that too little special oil is reaching the coil assembly. Remedy this by opening the regulating valve. In manipulating the special

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oil hand-regulating valve, do not turn the valve more than one turn either way at a time. Do not expect the dial thermometer to respond immediately. Such remedies as can be applied when the regulating valve proves ineffective are discussed in Section V.

g. Mechanical adjustments, repairs, and tests. Mechanical adjustments, service tests, and repairs, which may be necessary during the run of the generator, are discussed in Section V.

Fig. 67. Inserting a Clean Special Oil Level Gage in Tank.

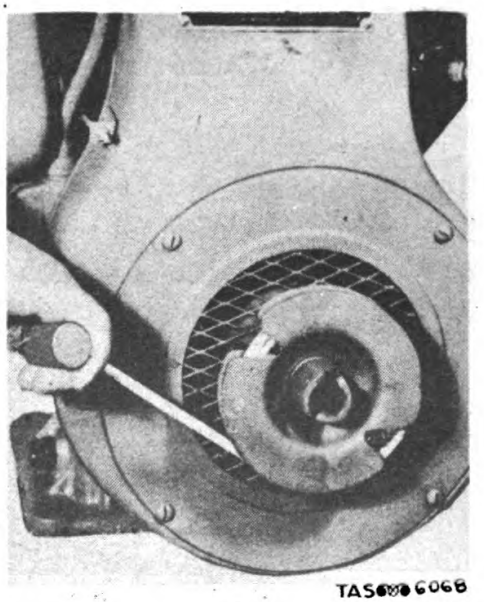

Fig. 68. Emergency Rope Starter for Engine.

18. STARTING THE ENGINE. a. General. The information in this paragraph supplements those portions of paragraph 13 concerning the steps to be taken in starting the engine to operate the smoke generator.

b. Procedure. Smooth starting of the engine is achieved

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by the following procedure:

(1) Before starting the engine, fill the base with good gasoline engine oil. (See Section IV.)

(2) Fill the gasoline tank with a good quality of gasoline free of dirt and water. (See Section IV.)

(3) Open the carburetor feed valve.

(4) Close the choke. (The choke opens automatically after the engine starts. It is closed by pushing the choke down.)

(5) The carburetor main discharge adjustment needle valve is about 3/4 turn to 1/4 turn. In cold weather starting is sometimes eased by turning the needle valve to a slightly more open position and then readjusting the needle valve, after the engine has started, to the position at which the engine runs smoothest. Some carburetors have fixed metering jets, in which cases needle valves are dispensed with.

(6) Be sure that the ignition switch lever is pushed in (that is, "on").

(7) Press the starter button. If the starter fails to operate, the engine may be started by a hand-crank or by rope. (See fig. 68.) To crank by rope, insert the knot at the end of the rope in the notch in the starting sheave at the flywheel end of the engine and wind the tope on the sheave in a clockwise direction. Then pull briskly on the rope to turn the crankshaft over. To crank by hand, engage the crank handle at the flywheel end of the engine crankshaft and turn the engine over briskly in a clockwise direction. Engage the crank so as to pull up on it. Pushing down is likely to cause the engine to back-fire and injure the operator's arm. If the engine does not start on the first application of crank or rope, repeat the operation.

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(8) If the choke on the carburetor accidentally snaps open during hand-cranking before the engine starts, the choke should again be closed for two or three turns of the engine. Do not keep the choke closed too long. If gasoline begins to drip from the carburetor, the choke should be opened. More choking is necessary in cold weather.

(9) Never operate the engine with any part of the air shroud removed as this will allow the engine to overheat and score. The air shroud is absolutely necessary to direct the air flow so that the engine is properly cooled.

(10) If the fuel oil burner back-fires when the engine is started, this is not necessarily an indication of trouble. Nine times out of ten the back-firing will cease after a few minutes of operation.

19. ADAPTING GENERATOR TO USE APPROVED OPERATING PROCEDURE. a. Adjustments. As explained in paragraph 13 above, it normally requires about 6 minutes to warm up the generator to the point where the control lever may be shifted to the "run" position and full operation of the generator initiated. This period can be materially shortened by performing the following adjustments:

(1) Close the shut-off valve.

(2) Remove the gage valve stem from the upper arm valve assembly on the glass gage of the accumulator. (See pars. 7 h and 27 c, and fig. 26.)

(3) Start the engine and warm up the generator in the "start-stop" position ONLY until water in the accumulator reaches a level of from 6-1/2 to 7 inches from the top of the accumulator. This can be determined by laying a straight-edge across the top of the accumulator and measuring the desired distance down the side of the glass gage.

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(4) Replace the upper arm valve stem tightly.

(5) Again start the engine and operate the generator in the "start-stop" position, this time setting the special oil flow through the fixed needle valve at 50 to 60 gallons per hour. This can be done by closing the fixed needle valve a trifle as described in paragraph 31 n. To determine at what point the fixed needle valve is adjusted to pass from 50 to 60 gallons per hour, open the petcock on the special oil manifold and measure the flow of oil from it. When a quart of special oil is being collected in from 15 to 18 seconds, the fixed needle valve is adjusted at the 50-60 gallons per hour rate.

b. Improved operating procedure. The unit is now adjusted so that it will warm up in a much shorter time. The first start will not be as short as succeeding ones because of the water remaining in the coil assembly from the last run. The second start after the above changes have been made, however, will reflect the improvement in starting time providing the improved operating procedure is followed as described below:

(1) Warm up the generator as described in paragraph 13. In about 2-1/2 to 3 minutes from a cold start the dial thermometer reading should rise to 500 degrees Fahrenheit.

(2) When the dial thermometer reaches 500 degrees Fahrenheit, push the control lever to the "run" position. DO NOT OPEN THE SPECIAL OIL HAND-REGULATING NEEDLE VALVE.

(3) When the dial thermometer reaches 700 degrees Fahrenheit, OPEN the hand-regulating valve gradually.

(4) The dial thermometer reading will now rise slowly to the operating range of 875-925 degrees Fahrenheit.

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During this period the operator should continue opening the hand-regulating valve gradually. After the thermometer reading has reached the 875-925 degree range it is maintained in the usual manner.

c. Reduced capacity operation. The piping on some smoke generators has been changed by the addition of reduced capacity jump-overs from the fuel-oil line to the fog-oil line at the manifold. All information pertaining to the changes in operating and disassembly procedures for smoke generators carrying these jump-overs is contained in Appendix IV.

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SECTION IV

FUELS

Paragraph

Special oil. 20
Fuel oil, water, and gasoline 21
Fuelling the generator. 22

20. SPECIAL OIL. a. Specifications. The special oil used in the mechanical smoke generator must be an all-distillate product from a petroleum source. It must contain no additives. Only oils meeting official specifications for special oil can be used. These specifications are set forth in Appendix II.

b. Weather factors. Smoke generators must operate in a variety of outdoor temperatures. For operation in temperatures of less than 40 degrees Fahrenheit the special oil must be thinned by adding to it specified amounts of the fuel oil used in the generator. The proportions of special oil and fuel oil required for various temperatures, together with the methods for blending them, will be found in Appendix II.

21. FUEL OIL, WATER, AND GASOLINE. a. Fuel oil. The fuel oil must be a clean distillate oil containing no visible dirt, and conforming to Commercial Standard No. CS-12-40 for No. 2 or No. 3 fuel oil, or U.S. Army Diesel Fuel Specification No. 2-102 b. No heavier fuel oil can be used under any circumstances. Specifications will be found in Appendix II.

b. Water. (1) Only clean, fresh, and preferably soft water should be used in the smoke generator. The rule is - if it's good enough to drink it's good enough for the generator. A strainer should always be used. A clean handkerchief will suffice if no better strainer is at hand.

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(2) When the temperature falls below 32 degrees Fahrenheit straight water must not be used as the freezing of pipes will seriously damage the smoke generator. The only anti-freeze recommended for use in the generator is denatured ethyl alcohol. To prevent freezing of the pipe connecting the spray nozzle manifold with the spray nozzle pressure gage, remove the pipe, drain it of water, and replace it whenever alcohol is added to the water. As previously noted, there is no spray nozzle pressure gage and piping on some units. For proper alcohol-water mixtures, for differing temperatures, see Appendix III.

(3) When weather conditions indicate a possible temperature fall to below 32 degrees Fahrenheit the following steps are recommended:

(a) Empty the water supply tank.

(b) Refill it with the proper alcohol-water mixture.

(c) Remove, drain, and replace the pipe connecting the spray nozzle manifold to the spray nozzle pressure gage.

(d) Test-run the generator until the water coming out of the spray nozzles indicates the presence of alcohol.

c. Gasoline. A good quality of gasoline free from dirt or water should be used in the gasoline tank. It should have an octane rating of at least 67.

22. FUELLING THE GENERATOR. a. Land-based generators. (1) No set method is prescribed for fuelling generator supply tanks. Methods currently in use vary in accordance with the type of equipment on which the generator is based or carried.

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(2) The special oil supply tanks of generators mounted in cargo trucks usually are filled in the manner shown in figures 69 and 70. A 55-gallon drum of special oil is mounted on a rack on the truck. One member of the two-man squad assigned to operate the generator stands on the ground or on the side of the truck and collects the special oil in a suitable container. When this container is filled he hands it to the other member of the squad who pours the special oil into the supply tank through a funnel.

(3) The special oil supply tanks of generators mounted on trailers and moved by the standard 2-1/2-ton cargo tank-truck issued to smoke generator companies (T/E 3-267) usually are fuelled from the tank-truck by means of 20-foot hose attached to a pump on the truck. (See fig. 71.)

(4) Normally fuel oil is carried in 5-gallon oil cans

Fig. 69. Filling Special Oil Supply Tank by Hand.

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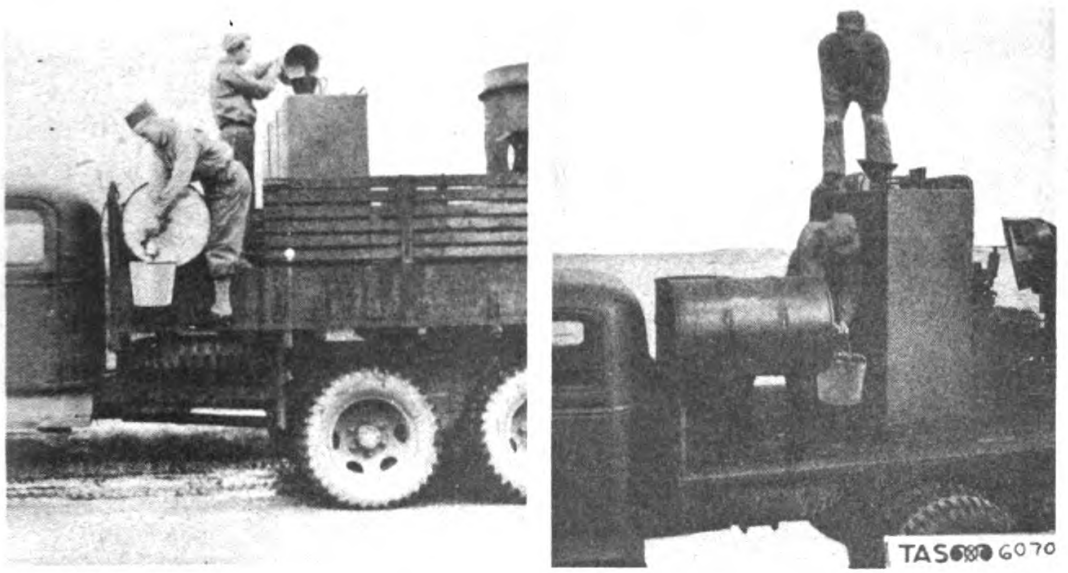

Fig. 70. Filling Special Oil Supply Tank by Hand.

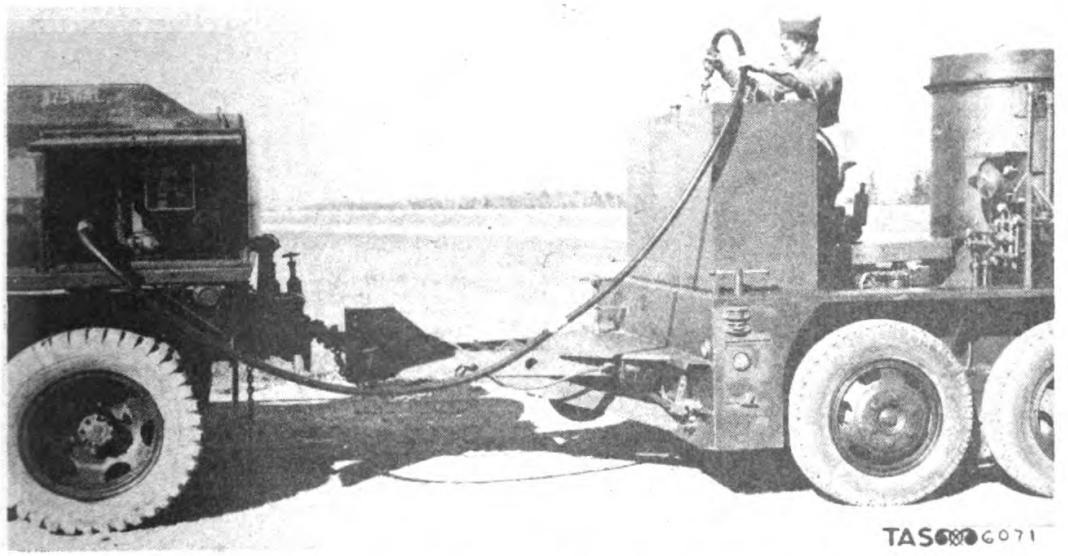

Fig. 71. Filling Special Oil Supply Tank by Hose.

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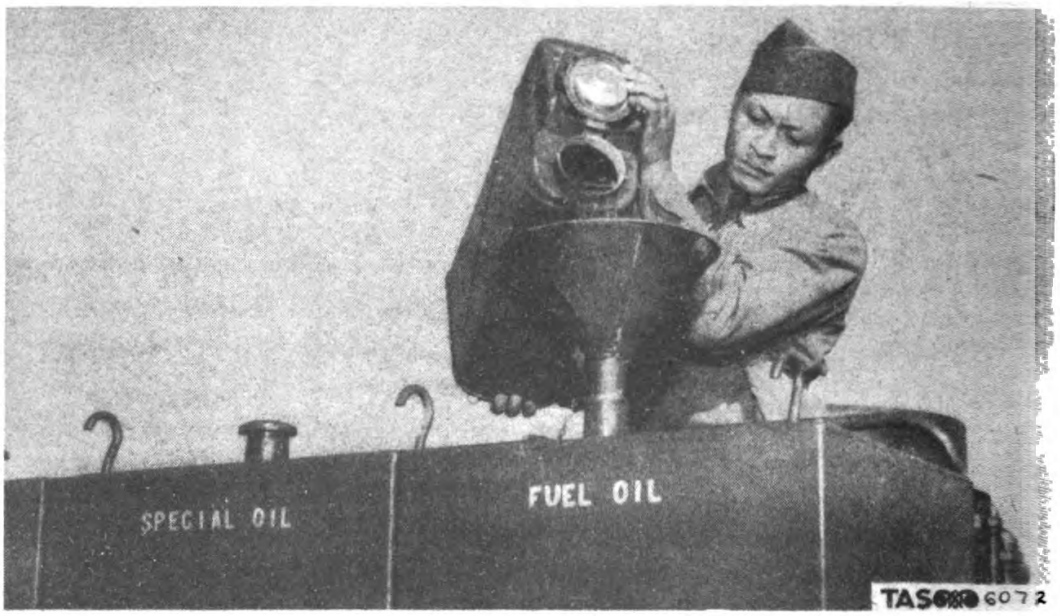

Fig. 72. Filling Fuel Oil Supply Tank.

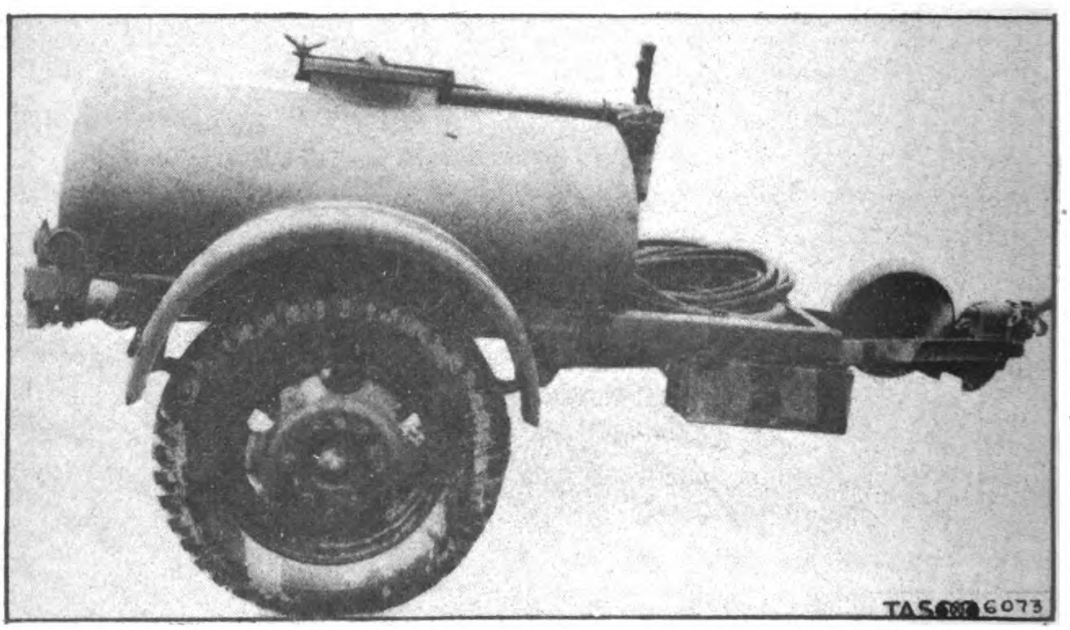

Fig. 73. 250-Gallon Water Trailer.

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on whatever transportation device is being used for the generator. It is poured into the fuel oil supply tank through a funnel. (See fig. 72.)

(5) Water supply tanks normally are filled from the storage tank of the 250-gallon water trailer, a specified number of these trailers being allotted to each smoke generator company. (See fig. 73.) Normally the trailer is drawn by a 2-1/2-ton cargo truck.

b. Offshore-based generators. Generators based offshore, on watercraft or pilings, normally are fuelled by hand from 55-gallon drums and 5-gallon cans carried on self-powered watercraft.

c. Reference. For a fuller discussion of fuelling techniques, see FM 3-50.

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SECTION V

MAINTENANCE

	Paragraph
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How to use maintenance section of manual	25
Disassembly - Special oil system	26
Disassembly - Water system	27
Disassembly - Fuel oil system	28
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23. ECHELONS OF MAINTENANCE. a. Echelons. Four maintenance echelons are prescribed for the care of all Chemical Warfare Service materiel. They are:

(1) First echelon: Maintenance by the individual. This, in the case of the mechanical smoke generator, is the operator.

(2) Second echelon: Maintenance by the using organization. This is the operations platoon of the smoke generator company.

(3) Third echelon: Maintenance involving the use of tools or trained personnel not available within the using organization. Usually this is performed by a chemical maintenance company.

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(4) Fourth echelon: Maintenance involving repairs at a factory or other permanent installation. In the case of the mechanical smoke generator, this will usually be the Heil Co., 3000 W. Montana St., Milwaukee, Wis., U.S.A.

b. Responsibility. (1) The maintenance, adjustment, and repair of practically all parts of the mechanical smoke generator are the responsibility of using personnel.

(2) The generator operator and his assistant are responsible for all maintenance which can be accomplished by means of the tools attached to the generator. They are responsible for seeing that all parts of the machine are kept clean and properly lubricated, that the supply tanks are properly filled at all times, and that the correct fuel mixtures are being maintained. They must make all tests necessary to discover the cause of difficulties, and must report to their section leader such difficulties that they themselves cannot remedy.

(3) The operations platoon of the smoke generator company is responsible for all maintenance, aside from that accomplished by the operator and his assistant, that can be performed with the tools and spare parts issued to the company.

(4) To the rule - that responsibility for maintaining the generator rests with using personnel - the following specific exceptions are made:

(a) Only minor adjustments should be made on the pumps. When a pump is seriously damaged, remove and send it to one of the six supply depots listed in paragraph 23 c. At the same time, requisition a spare pump from the depot.

(b) Should the steel shell of the furnace be punctured by hostile fire or other means, the coil assembly should be removed from the furnace and the remainder of the furnace removed from the generator and transported to one of the six

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supply depots listed in paragraph 23 c. Requisition a spare furnace from the depot. A damaged coil assembly is handled in the same manner.

(c) The engine generator commutator sometimes becomes rough, or out-of-round, or develops high mica, in which case the armature must be removed and turned down in a lathe. Since normally the smoke generator company is not equipped with a lathe and does not have personnel trained for this sort of repair, the armature should be transported to the nearest chemical maintenance company.

(d) Adjustment of the engine crankshaft is normally a third echelon undertaking. Remove the engine from the generator and ship it to the nearest chemical maintenance company.

(e) All damage to the generator which calls for the use of welding equipment is normally third or fourth echelon maintenance. If, however, the using unit can obtain welding equipment from any source, it should perform repairs on broken supply tanks, etc., itself. Otherwise, the part in need of welding should be removed from the generator and sent to the nearest chemical maintenance company.

(f) Under such combat conditions as may arise in areas where the generator is being employed, repair on the spot may prove impossible or inadvisable. In such cases, third echelon maintenance may be resorted to at the discretion of the officer in charge.

(g) Inside the pump and guard assembly of the fuel oil burner is an air control plate for regulating the flow of air required for combustion of the fuel oil. This is set at the factory, and should under no circumstances be tampered with. If incorrectly set so that it is closed too much, black smoke may emerge either from the spray nozzle manifold or from the

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urnace itself. When this occurs, remove the pump and guard ssembly, send it to the factory if possible, and replace with a pare assembly.

(h) If it is found that an atomizing nozzle is not eating properly due to the presence of a burr on the body or hield of the combustion head assembly in the burner, remove ıe defective part and send it to the nearest chemical maintenance company with instructions to reface it in a lathe. Do not ttempt to remedy the defect with a file.

c. Chemical Warfare Service depots. Six Chemical Warfare Service depots carry spare parts for the generator. They are:

(1) Edgewood Chemical Warfare Depot,
Edgewood Arsenal, Md.

(2) Chemical Warfare Section,
Memphis Quartermaster Depot,
Memphis, Tenn.

(3) Chemical Warfare Section,
Ogden General Depot,
Ogden, Utah.

(4) Indianapolis Chemical Warfare Warehouse,
Indianapolis, Ind.

(5) Huntsville Chemical Warfare Depot,
Huntsville, Ala.

(6) Chemical Warfare Section,
New Cumberland Quartermaster Depot,
New Cumberland, Pa.

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24. GENERAL RULES FOR CARE OF THE GENERATOR. a. Scope. This paragraph contains data on how to lubricate the generator and how to care for the battery, together with some general rules designed to prevent breakdown and to maintain the generator at the highest possible level of efficiency.

b. General. (1) KEEP THE GENERATOR CLEAN, ESPECIALLY THE SPECIAL OIL SYSTEM. This is the most important single rule and cannot be followed too conscientiously. Dirt in any of the systems almost always causes serious trouble. For example, a speck of dirt in the special oil may lodge in the seat of a valve, causing the valve to stick open when it should be closed or to clog when it should be open. The malfunctioning of this one valve causes the generator to produce bad smoke, necessitating a shut down of the machine followed by a lengthy check to discover the cause of the trouble.

(a) Never use a dirty funnel, pipe, or container.

(b) When fuelling the generator, keep hose off the ground. Wipe off openings of hose before using. USE CLOTHS WHICH WILL NOT DEPOSIT LINT ON THE HOSE OPENING. Lint is dirt as far as the smoke generator is concerned.

(c) Do not pump or pour fuel into the generator from the bottom of containers. Dirt always collects in the bottoms of fuel containers.

(d) Wipe dirt off the bungs of barrels from which fuel is being pumped or poured. Use lintless rags.

(e) Be certain that any measuring sticks or gages to be inserted in the generator supply tanks are dirt and lint free.

(f) Under dusty conditions, keep all containers tightly covered.

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(g) Take particular care in the handling of special oil. Special oil is thick; dirt does not settle out of it quickly. Keep it free of water.

(h) Be sure that no water gets into the fuel oil.

(2) NEVER REPLACE AN IRON PIPE FITTING WHICH HAS BEEN REMOVED FROM THE GENERATOR WITHOUT FIRST LUTING ITS THREADS WITH "PIPE DOPE." Acceptable "pipe dopes" are paint, white lead, key paste, oil dope, gas dope, and shellac. Apply one of these to the threads with either a small brush or with the fingers.

(3) TAKE CARE IN HANDLING THE COPPER TUBING OF THE FUEL OIL SYSTEM. This tubing is easily broken. Never use a heavy wrench on its fittings. Use an open-end wrench. This tubing does not require luting.

(4) USE ONLY OPEN-END WRENCHES, BOX WRENCHES, OR SOCKET WRENCHES ON VALVES AND BOLTS. Heavy wrenches should never be used on these items. Bolts become rounded when adjusted with heavy wrenches. Valve caps and bonnets become distorted.

(5) NEVER OPERATE THE MACHINE (except in the case of destruction procedures as described in Section VI) WITHOUT FIRST MAKING SURE THAT ALL GATE VALVES ARE OPEN. Operation of the pumps "dry" will seriously damage them.

(6) IN ALL DISASSEMBLY PROCEDURES, CHECK ALL GASKETS CAREFULLY AND REPLACE THOSE WHICH ARE WORN.

(7) Before a new generator is operated for the first time, remove the paper covers from the spray nozzles. It is recommended also that the shut-off valve be closed and the gen-

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erator operated without heat to make sure that the special oil pump is taking suction and building up 55-60 pounds pressure on the special oil pressure gage. It may be necessary to bleed some special oil and air from the petcock on the special oil manifold to build up the proper pressure. When this has been done the engine should be shut down before the shut-off valve is opened wide.

c. Lubrication. Each smoke generator is lubricated at the factory before shipment. On arrival at the place of use it should be relubricated at once. A diagram showing location of lubricating points, frequency of lubrication, and types of oil and grease to be used is shown in figure 74. Detailed instructions for lubricating important components follow:

(1) Crankcase. The type of oil to be used in the crankcase varies with weather conditions, and when a weather change occurs the crankcase must be drained and refilled at once. For temperatures between 40 and 120 degrees Fahrenheit, use SAE No. 30. For temperatures between 0 and 40 degrees Fahrenheit, use SAE No. 20. For temperatures between 0 and -15 degrees Fahrenheit, use SAE No. 10 W. The crankcase holds 1-1/2 quarts of oil. It is filled through the oil filler plug of the oil-fill pipe projecting upward from the base of the engine. It should be checked frequently and oil added when necessary to keep the level up to the plug. Drain and refill the crankcase every 50 hours of operation. The drain plug is located at the side of the crankcase below the oil filler plug.

(2) Oil bath air cleaner assembly. Under dusty conditions the oil bath air cleaner assembly on the carburetor should be drained and refilled with SAE No. 20 oil every 25 hours of operation. Where little dust is present, drain and refill every 50 hours.

(3) Alternating current generator on transformer-ignition models. On units whose burner mixtures are ignited

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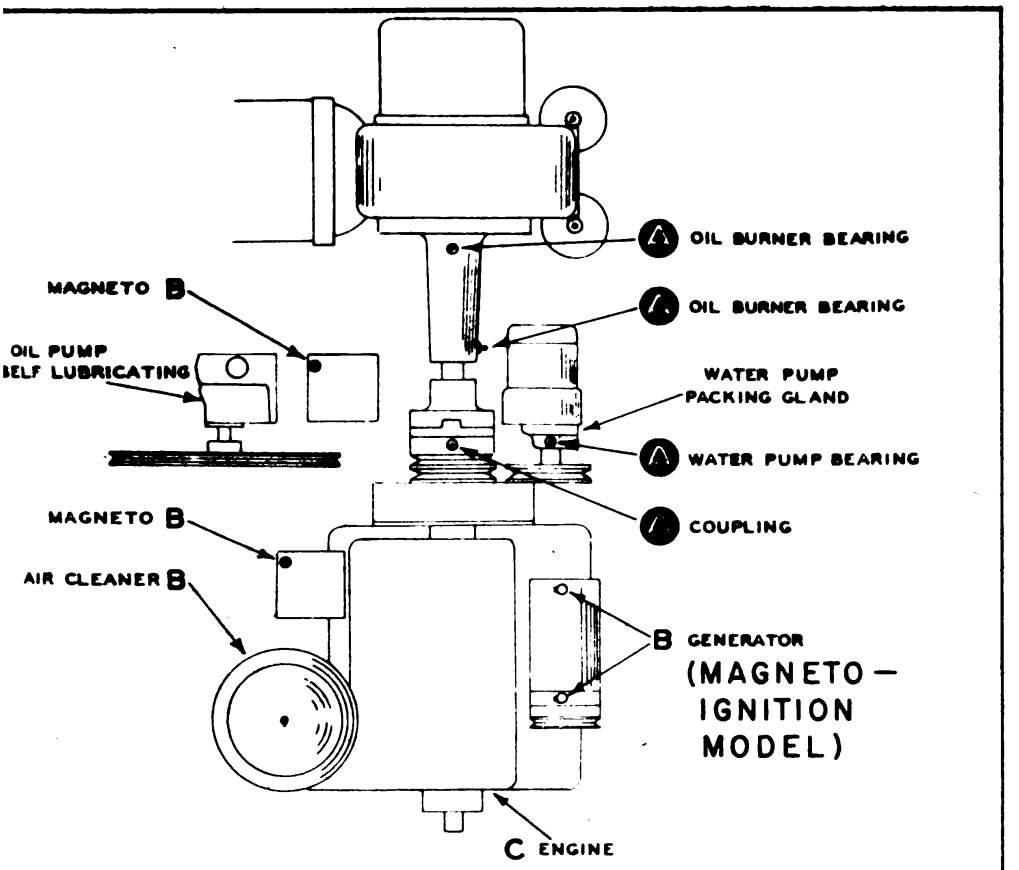

LUBRICATION CHART

SYMBOL	FREQUENCY	TYPE OF LUBRICANT	HOW APPLIED
●	EVERY 25 HOURS	LIGHT ALEMITE GREASE OR EQUIVALENT	GREASE FITTING
B	EVERY 200 HOURS AIR CLEANER EVERY 25 HR.	S.A.E. Nº 20	OILER
C	EVERY 50 HOURS	SEE OIL CHART	OIL FILL PLUG

ENGINE LUBRICATION CHART

SEASON	TEMP	TYPE OF OIL
SPRING SUMMER AUTUMN	120° TO 40°F	S.A.E. Nº 30
WINTER	+40° TO 0° F	S.A.E. Nº 20
WINTER	0° TO -15° F	S.A.E. Nº 10W

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Fig. 74. Lubrication Diagram.

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by transformer, the engine alternating current generator will require lubrication only at overhaul periods. Use SAE No. 20 oil.

(4) Engine generator on magneto-ignition models. On units whose burner mixtures are ignited by magneto, the engine generator must be lubricated every 200 hours of operation. Use SAE No. 20 oil and fill the oilers. One oiler will be found on the drive end head, the other on the commutator end plate.

(5) Engine magneto. The engine magneto must be lubricated every 200 hours of operation. It is provided with oilers on each side of the main housing replacement group marked, "Use Light Oil," so that whichever way the magneto faces one oiler will always be convenient. Remove the screw and fill the oiler to overflowing with SAE No. 20 oil. After every 1,000 hours of service, relubricate the main oil pad. This is done by removing the pad and squeezing and working into it some stringy grease. A summer grade of automobile transmission grease is good. Do not use ordinary grease.

(6) Burner magneto on magneto-ignition models. For lubrication of the pulley-driven magneto for the burner, follow instructions for the engine magneto.

(7) Fuel oil burner. Lubricate the grease fitting on the burner with the pressure grease gun found in the generator tool kit every 25 hours of operation or once a month, whichever period elapses first. Use light alemite grease or its equivalent.

(8) Flexible coupling. Lubricate the grease fitting on the flexible coupling on the burner end of the engine take-off shaft every 25 hours of operation or once a month, whichever period elapses first. Use light alemite grease or its equivalent.

(9) Water pump. The water pump alemite fitting is

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n the bearing cage of the pump. Lubricate it every 25 hours r once a month, whichever period elapses first. Use light ale- ıite grease or its equivalent.

(10) Special oil pump. No lubrication of the special il pump is required. Bearings are iron and are renewable.

d. Battery and generator. (1) Check the battery before ıe generator is put into operation, and recheck it at least once week. Inspect terminals, hold-down clamps, and the level of lectrolyte (liquid in battery cells) carefully.

(2) Check each cell with a hydrometer. Reading on fully charged battery should be between 1,260 and 1,300. When he battery reading falls below 1,200, remove and recharge the attery. Add pure, preferably distilled, water to each cell un- il the water level is approximately 3/8-inch above the plate.)o not overfill the cells.

(3) In cold weather, water should be added to battery :ells before every operation of the smoke generator. Unmixed vater will freeze. The specific gravity chart shown in figure 75 gives the freezing point of electrolyte at various stages of :harge or specific gravities.

Fig. 75. Specific Gravity Chart.

Specific Gravity	Freezing Temp.
1100	18 Deg. F.
1140	8 Deg. F.
1160	2 Deg. F.
1200	- 17 Deg. F.
1240	- 51 Deg. F.
1260	- 75 Deg. F.
1300	- 95 Deg. F.

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(4) On smoke generators equipped with transformer-ignition for the burner mixture the battery charging rate may be increased by temporarily shorting out the resistor. This should be done only to bring the battery charge up when it is abnormally low.

25. HOW TO USE MAINTENANCE SECTION OF MANUAL. a. Scope. This section of the manual deals with first and second echelon maintenance of the smoke generator.

b. Plan. (1) Paragraphs 26 through 30 are devoted to instructions on removing, disassembling, assembling, and attaching those generator parts most likely to give trouble. The information is arranged as follows: First, the name of the system is given as part of the main paragraph heading. Under it are listed the parts most likely to give trouble. Under the name of each part is given a description of how to remove the part from the system, disassemble, assemble, and attach it, together with the tool most likely to prove useful for each step. Where no tool is likely to be necessary, the word "hand" is used, indicating that as a rule the operation can be performed manually. The disassembly procedures given in this manual are listed merely as a guide to using personnel. Slight modifications are made from time to time in the construction of smoke generator parts. Where these modifications are found, it may be necessary to deviate slightly from the disassembly procedures given.

(2) Paragraph 31 is devoted to instructions on how to clean, adjust, and repair those parts of the generator most likely to need this attention. Each part is named. Under the name, instructions for its care, adjustment, and repair are given.

(3) Paragraphs 32 and 33 are devoted to troubles which are likely to arise and checks or tests which may be made in an effort to discover the cause or causes, together with available information for correcting the trouble.

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26. DISASSEMBLY - SPECIAL OIL SYSTEM. a. Supply ank. (1) To remove tank from generator.

PROCEDURE	TOOLS
.. Unscrew gage body on top of tank.	1. Open-end wrench.
2. Lift gage body and attached links and floats out of tank and lay them aside on a clean, lintless cloth.	2. Hand.
3. Loosen and remove screws holding floor plate behind tank to generator frame. In cold weather, these screws are likely to stick; loosen with chisel and hammer.	3. Screwdriver, chisel, hammer.
4. Remove floor plate from frame.	4. Hand.
5. Break special oil suction line by removing 1" M. & F. union on pump side of gate valve. Place clean receptacle under valve, open valve, and allow contents of supply tank to escape. Remove valve and 1" close nipple holding it to tank by twisting them free with the hand, or with a wrench if the pipe system is tight and	5. Pipe wrench and clean pail.

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PROCEDURE	TOOLS
has not been dismantled before.	
6. Break special oil return line by removing 1" M. & F. union on pump side of check valve; then remove valve and 1" close nipple holding it to tank by twisting them free by hand. (See fig. 76.)	6. Pipe wrench.
7. Remove tank – attaching screw nuts holding tank to frame.	7. Open-end wrench.
8. Remove tank from frame.	8. Hand.

(2) To replace tank on generator.

1. Replace tank on generator frame, and bolt it in place.	1. Hand and open-end wrench.
2. Screw check valve and nipple into tank and reconnect to return line by replacing and tightening union. Repeat with gate valve on suction line.	2. Hand and pipe wrench.
3. Replace floor plate. Some units require the use of a 3/8-inch open-end wrench to replace screws holding the floor plate. If the wheel	3. Screwdriver and open-end wrench.

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PROCEDURE	TOOLS
nuts and hand-wheels extend above the floor plates, as on some models, these must be removed first.	
4. Insert gage floats and links in tank and screw in gage body.	4. Hand and open-end wrench.

b. Supply tank gage. (See fig. 12.) (1) To disassemble.

1. Remove gage body, floats and links from tank as directed in paragraph 26 a above.	1. Open-end wrench and hand.
2. Disengage the top float connecting link from hook of spring hook in gage body and lay links and floats to one side.	2. Hand and pliers.
3. Loosen and remove glass retaining plug, and remove from body and lay out in the order listed, the following: equalizing washer, glass gage and gasket (do not disassemble gage from gasket), spring hook, and spring.	3. Hand, open-end wrench, and pliers.

(2) To assemble.

1. Insert in gage body these	1. Hand.

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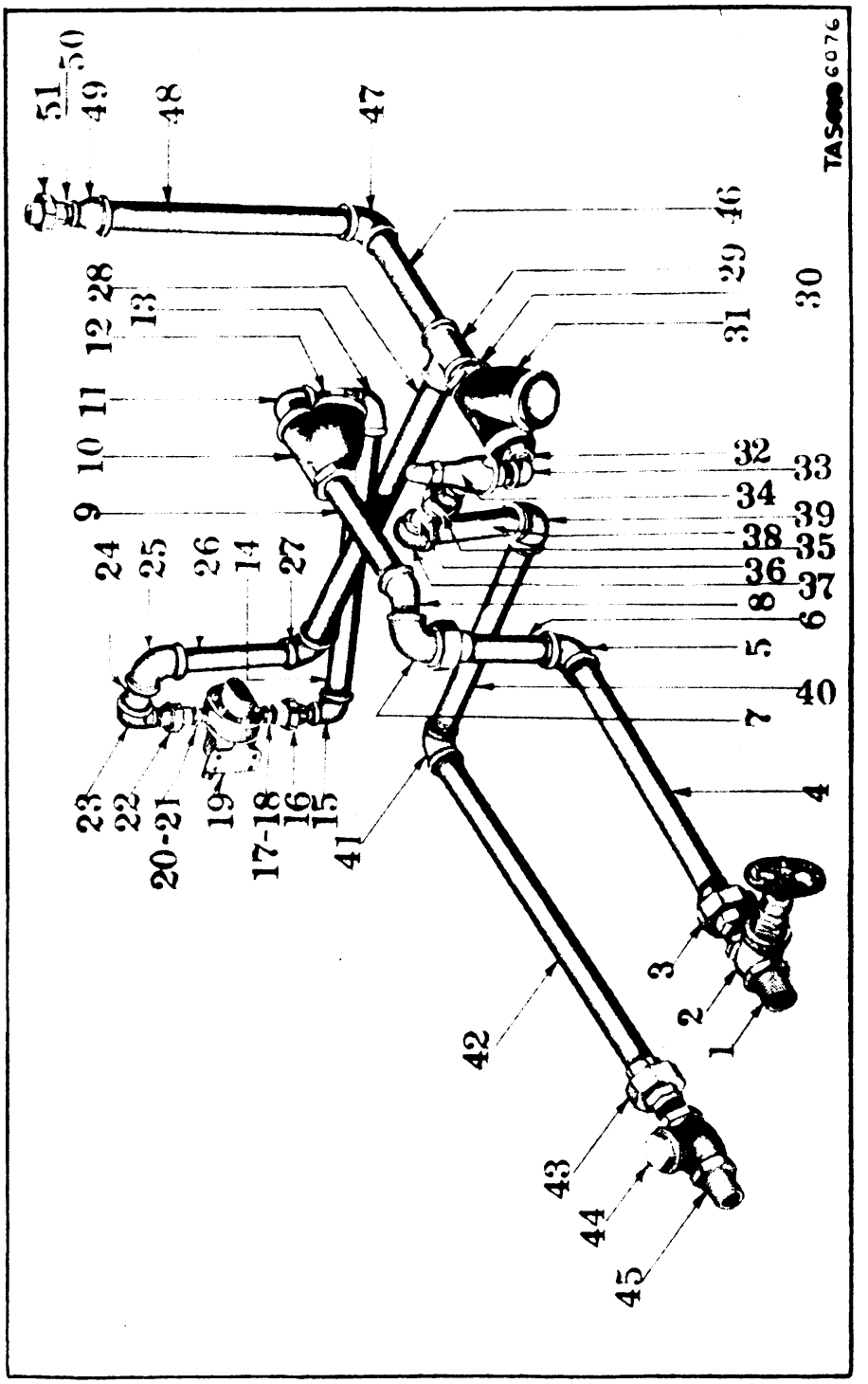

Fig. 76. Pipe Fittings of Special Oil Suction, Discharge, and Return Lines.

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1. Nipple - Close, 1"
2. Valve - Gate, 1" (Crane)
3. Union - M & F, 1"
4. Nipple - 1" x 16-1/4"
5. Elbow - 1", 90°
6. Nipple - 1" x 5"
7. Elbow - Union, 1"
8. Elbow - Street, 1" x 45°
9. Nipple - 1" x 7"
10. Strainer - 1"
11. Elbow - Street 1"
12. Nipple - 1" x 3-1/2"
13. Elbow - 1" (angle back to left about 15°)
14. Nipple - 1" x 15"
15. Elbow - Reducing, 1" x 1/2"
16. Union - M & F, 1/2"
17. Bushing - 1/2" x 3/8"
18. Nipple - Close, 3/8"
19. Pump - Oil (bottom tapping)
20. Nipple - Close, 3/8"
21. Bushing - 1/2" x 3/8"
22. Union - M & F, 1/2"
23. Elbow - Reducing, 1" x 1/2"
24. Nipple - 1" x 2-1/2"
25. Elbow - 1"
26. Nipple - 1" x 7"
27. Elbow - 1"
28. Nipple - 1" x 18"
29. Tee - 1"
30. Nipple - Close, 1"
31. Strainer - 1"
32. Bushing - 1" x 1/2"
33. Elbow - Street, 1/2"
34. Valve - Relief, 1/2" (Crane)
35. Union - M & F, 1/2"
36. Nipple - 1/2" x 2-1/2"
37. Elbow - Reducing, 1" x 1/2"
38. Nipple - 1" x 5-1/2"
39. Elbow - 1"
40. Nipple - 1" x 12-1/2"
41. Elbow - 1"
42. Nipple - 1" x 20-1/2"
43. Union - M & F, 1"
44. Valve - Swing check, 1" (Crane)
45. Nipple - Close, 1"
46. Nipple - 1" x 8"
47. Elbow - 1"
48. Nipple - 1" x 12-1/2"
49. Reducer - 1" x 1/2"
50. Nipple - 1/2" short
51. Union - 1/2"

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PROCEDURE	TOOLS
parts in the order listed: spring, hook, glass gage and gasket, and equalizing washer.	
2. Replace glass retaining plug on glass gage and tighten.	2. Open-end wrench.
3. Attach top connecting float link to hook inside gage body.	3. Hand and pliers.
4. Insert floats and links in supply tank and screw gage body into tank.	4. Hand and open-end wrench.

c. Gate valve. (See fig. 13.) (1) To remove from suction line and disassemble.

1. Remove floor plate as directed in 26 a above.	1. Screwdriver and open-end wrench.
2. Break suction line and remove valve and nipple from tank as directed in 26 a above. (See fig. 76.)	2. Pipe wrench and hand.
3. Hold valve firmly with one wrench. Remove nipple with other.	3. Two pipe wrenches.
4. Loosen wheel nut, packing nut, stuffing box, and bonnet of valve assembly. De-	4. Open-end wrenches.

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PROCEDURE	TOOLS
tach from valve body and lay out in the order listed: wheel nut, hand-wheel, packing nut, gland, stuffing box, stem, bonnet, and disk.	
(2) To assemble and attach to suction line.	
1. Place following parts on smooth part of stem in the order listed: stuffing box, gland, packing nut, hand-wheel, and wheel nut. Tighten nuts and stuffing box. Place bonnet on threads of stem and screw bonnet into stuffing box. Tighten bonnet.	1. Hand and open-end wrenches.
2. Screw disk onto threads of stem below bonnet. Insert disk and parts assembled to it in body of valve. Tighten nuts and turn hand-wheel to seat disk.	2. Hand and open-end wrench.
3. Screw nipple into valve. Insert valve and nipple in tank, and re-attach them to suction line by replacing and tightening union. (See paragraph 26 a above.)	3. Hand and pipe wrenches.
4. Replace floor plate as directed in paragraph 26 a	4. Screwdriver and open-end wrench.

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PROCEDURE	TOOLS
above.	
d. Basket-type screen strainer. (See fig. 14.) (1) To remove from suction line and disassemble.	
1. Be sure that special oil gate valve is closed.	1. Hand.
2. Hold strainer firmly by placing open-end on flange. Then remove the 1" x 45° street elbow and the 1" street elbow to either side of strainer. (See fig. 76.)	2. Pipe wrench and open-end wrench.
3. Remove strainer assembly and attached 1" x 7" nipple. (See fig. 76.)	3. Hand.
4. Holding strainer with one wrench, remove nipple with the other.	4. Two pipe wrenches.
5. Remove cap of strainer assembly.	5. Open-end wrench.
6. Remove screen from body.	6. Hand.
(2) To reassemble and replace strainer.	
1. Insert screen in body and replace cap.	1. Hand and open-end wrench.
2. Re-attach strainer assembly to long 1" nipple on tank	2. Two pipe wrenches.

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PROCEDURE	TOOLS
side. Do this by holding nipple firm with one wrench, then twist strainer assembly onto threads of nipple with aid of the other wrench.	
3. Hold flange of strainer with open-end wrench and replace elbows holding strainer and nipple to suction line.	3. Pipe wrench and open-end wrench.

e. Self-cleaning strainer. (See fig. 15.) (1) To remove from system and disassemble.

1. Be sure that special oil gate valve is closed.	1. Hand.
2. Remove strainer assembly from system as directed in paragraph 26 d above. On some models a 4" hole is cut in the floor plate directly below the sump of this filter. The sump can be dropped by loosening the 10 sump screws and lowering it partially through the hole. This permits the filter to be cleaned and inspected without dismantling the piping.	2. Pipe wrenches.
3. Loosen screws under rim	3. Screwdriver.

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PROCEDURE	TOOLS
at top of sump assembly. (See fig. 79.)	
4. Lift cartridge assembly out of sump and remove head gasket.	4. Hand.
5. Remove drain plug at bottom of sump assembly.	5. Open-end wrench.

(2) To assemble and re-attach to system.

1. Replace drain plug; replace head gasket, insert cartridge assembly in sump assembly, insert and tighten screws holding head to sump assembly.	1. Hand, open-end wrench, and screwdriver.
2. Re-attach strainer assembly to system as directed in paragraph 26 d above.	2. Hand and pipe wrenches.

f. Special oil pump. (See fig. 16.) (1) To remove from system.

1. Remove pump attaching cap screws holding pump to equipment frame bracket.	1. Open-end wrench.
2. Remove the 1/2" unions on piping above and below pump.	2. Pipe wrench and open-end wrench.

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PROCEDURE	TOOLS
3. Remove pump assembly from system by holding pulley belt away from pulley and lifting pump assembly up.	3. Hand.
4. Remove all bushings and nipples from pump assembly.	4. Open-end wrench.

(2) To attach to system.

1. Replace all bushings and nipples.	1. Open-end wrench.
2. Hold pump assembly in place and replace belt on pulley.	2. Hand.
3. Re-attach pump to piping by replacing and tightening unions.	3. Pipe wrenches and open-end wrench.
4. Re-attach pump to equipment frame bracket.	4. Open-end wrench.

(3) To disassemble and assenble. Remove stand screws and take pump apart, laying components out in the order pictured in figure 16. Assemble in the same order and tighten stand screws.

g. Relief valve. (See fig. 17.) (1) To remove from system and disassemble.

1. Remove 1/2" M. & F. union	1. Pipe wrench.

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PROCEDURE	TOOLS
on tank side of valve. (See fig. 76.)	
2. Remove valve assembly and street elbow and bushing by which it is connected to return line strainer by twisting them loose from strainer. Note that strainer may now be loosened and removed from return line.	2. Hand or pipe wrench.
3. Hold valve assembly with one wrench, remove elbow and bushing with the other	3. Pipe wrenches.
4. Loosen and remove valve top, big screw, small screw, nut, and packing from valve body.	4. Open-end wrench and pliers.
5. Loosen and remove seat, adjusting nut, poppet, stem, spring, and washer from valve body.	5. Open-end wrench.
(2) To assemble and attach valve to system.	
1. Insert small screw in valve body; then place the following on valve body in the order named: washer, nut, large screw, and top. Tighten all parts.	1. Hand, pliers, and open-end wrench.

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PROCEDURE	TOOLS
2. Screw adjusting nut onto threads of seat, insert poppet and stem in seat; place spring and washer on long end of stem; insert lower half of valve in body and tighten.	2. Hand and open-end wrench.
3. Re-attach valve assembly to system.	3. Pipe wrenches.

h. Check valve. (See fig. 18.) (1) To remove from system and disassemble.

1. Break return line and remove valve assembly and 1" close nipple from system as directed in paragraph 26 a. (See fig. 76.)	1. Pipe wrenches.
2. Place receptacle under tank opening and catch all escaping fuel.	2. Clean pail.
3. Remove valve cap.	3. Open-end wrench.
4. Remove hinge pin plug on side of body.	4. Open-end wrench or pliers.
5. Pull out hinge pin.	5. Hand or pliers.
6. Turn valve upside down and drop hinge out of body.	6. Hand.

(2) To assemble and attach to system.

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PROCEDURE	TOOLS
1. Insert hinge in body; insert pin; re-attach hinge pin plug and tighten; replace and tighten cap.	1. Hand, open-end wrench and pliers.
2. Attach nipple to valve and attach valve to system as directed in paragraph 26 a.	2. Pipe wrenches.

i. Hand-regulating glove needle valve. (See fig. 20.)

(1) To remove from system and disassemble.

1. Remove special oil pressure regulating gage.	1. Pipe wrench.
2. Remove 1/2" union on dial thermometer side of fixed needle valve; remove 1/2" union at base of manifold. (See fig. 77.)	2. Pipe wrench.
3. Loosen that part of manifold carrying regulating valve by twisitng it loose from remainder of manifold at 1/2" close nipple on petcock side of valve. (See fig. 77.)	3. Pipe wrenches and hand.
4. Remove pipe fittings from valve assembly. (See fig. 77.)	4. Pipe wrenches and open-end wrenches as needed.
5. Loosen wheel nut, gland nut, and gland, and remove	5. Open-end wrenches.

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PROCEDURE	TOOLS
all valve parts in this order: wheel nut, hand-wheel, gland nut, bushing packing, gland, stem, and body.	
(2) To assemble and attach to system.	
Place gland, bushing packing, gland nut, hand-wheel, and wheel nut on stem. Tighten all parts.	1. Open-end wrench and hand.
Attach valve assembly to pipe fittings and replace on system.	2. Pipe wrenches.
j. Fixed needle valve. (See fig. 19.) (1) To remove om system and disassemble.	
Remove 1/2" union on dial thermometer side of valve. (See fig. 77.)	1. Pipe wrench.
Loosen and remove valve body from manifold.	2. Open-end wrench.
Loosen and remove adapter nut and adapter from body.	3. Open-end wrench.
Loosen and remove top, bushing, gland packing, and stem from body.	4. Open-end wrench.
(2) To assemble and attach to manifold.	

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PROCEDURE	TOOLS
1. Replace adapter and adapter nut on body and tighten nut.	1. Hand and open-end wrench.
2. Insert stem in top; put bushing in gland packing; place packing in top; then replace packing and all parts assembled to it in valve body.	2. Open-end wrench and hand.
3. Attach valve assembly to manifold.	3. Open-end wrench and pipe wrench.

k. Quick-opening gate valve. (See fig. 21.) (1) To remove from manifold and disassemble.

1. Remove cotter pin holding connecting link to special oil quick-opening valve lever. (See fig. 77.)	1. Pliers.
2. Loosen lever from connecting link. (See fig. 77.)	2. Hand.
3. Loosen lever from valve assembly. (See fig. 77.)	3. Open-end wrench.
4. Holding line firmly. with one wrench, loosen and remove nipple and reducer coupling to rear of valve. Then with pipe wrenches twist valve loose from system. (See fig. 77.)	4. Two pipe wrenches.

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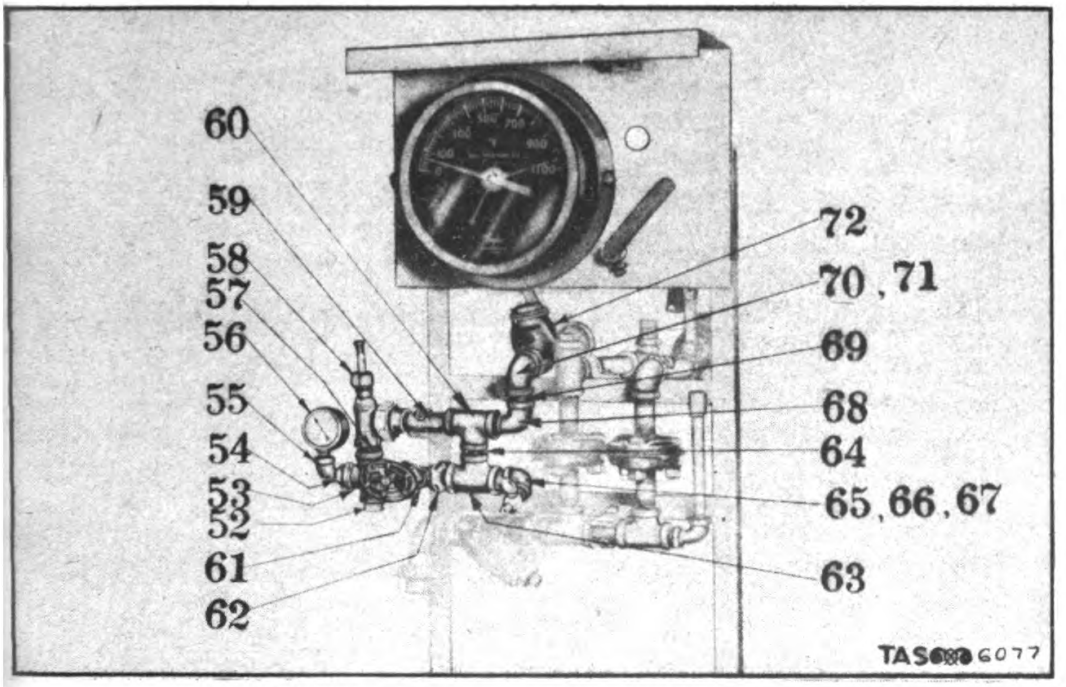

Fig. 77. Pipe Fittings on Front Portion of Special Oil Manifold.

52. Nipple - Short, 1/2"
53. Cross - 1/2"
54. Bushing - 1/2" x 1/4"
55. Elbow - Street, 1/4"
56. Gage - oil pressure
57. Nipple - Close, 1/2"
58. Valve - Angle needle, 1/2" (Crane)
59. Nipple - 1/2" x 3"
60. Tee - 1/2"
61. Valve - Needle, 1/2" (Crane)
62. Nipple - Close, 1/2"
63. Tee - 1/2"
64. Nipple - Close, 1/2"
65. Nipple - Close, 1/2"
66. Elbow - Reducing, 1/2" x 1/4"
67. Cock - 1/4"
68. Elbow - Street, 1/2"
69. Nipple - Close, 1/2"
70. Elbow - 1/2"
71. Nipple - Close, 1/2"
72. Valve - Quick-opening, 1/2" (Crane)

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PROCEDURE	TOOLS
5. Loosen lever nut and lever, packing nut, and stuffing box. Remove these and the gland from stem. Pull stem out of body.	5. Open-end wrenches.
6. Unscrew and remove cap, and turn body upside down to permit disk to drop out.	6. Hand and open-end wrench.

(2) To assemble and attach to manifold.

1. Replace parts in this order: insert disk in valve body; insert gland packing in stuffing box; place packing nut on stuffing box; insert long end of stem in lower end of stuffing box; insert short end of stem in body opening so as to attach it to disk; replace cap and tighten.	1. Hand and open-end wrenches.
2. Attach valve assembly to manifold by replacing and tightening nipples, ell, and coupling.	2. Pipe wrenches.

(Note: Make certain that the two water pipes are correctly alined and properly spaced in relation to each other and to the special oil line. If this alinement is not correct the quick-opening valves will not operate properly. On many recent models

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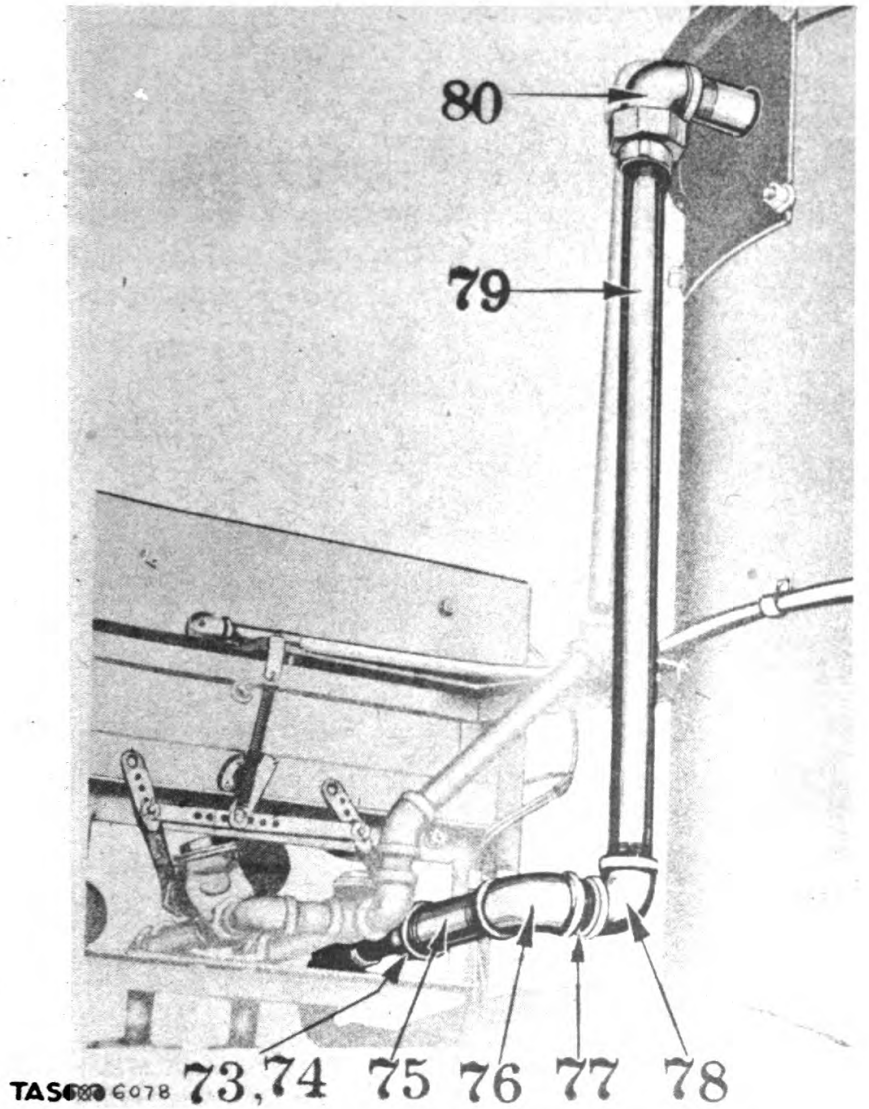

Fig. 78. Pipe Fittings on Rear Portion of Special Oil Manifold.

73. Nipple - 1/2" x 3"
74. Coupling - Reducer, 1/2" x 1"
75. Nipple - 1" x 6-1/2"
76. Elbow - 1"
77. Nipple - 1" x 2"
78. Elbow - 1"
79. Nipple - 1" x 22-1/2"
80. Elbow - Union, 1"

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a brace is used between the water lines and the special oil line to insure a correct alinement of these pipes.)

27. DISASSEMBLY - WATER SYSTEM. Many parts of this system are removed or disassembled, or both, in essentially the same manner as parts bearing identical names on the special oil system. Procedures not previously covered are given below:

a. Filter. (See fig. 24.) (1) To remove and disassemble.

PROCEDURE	TOOLS
1. Remove 1/2" union on tank side of filter.	1. Pipe wrench.
2. Hold 1/2" elbow on pump side with wrench and twist filter and pipe fittings loose at nipple on pump side. (See fig. 79.)	2. Hand and pipe wrench.
3. Remove pipe fittings still attached to filter head.	3. Pipe wrenches.
4. Remove cap screws holding filter head to shell.	4. Open-end wrench.
5. Remove head; remove gasket; pull element out of shell.	5. Hand.

(2) To assemble and attach to system.

1. Replace element and gas-	1. Open-end wrench.

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PROCEDURE	TOOLS
ket and rebolt head to shell.	
2. Re-attach pipe fittings to filter head and attach filter assembly to system.	2. Pipe wrenches.

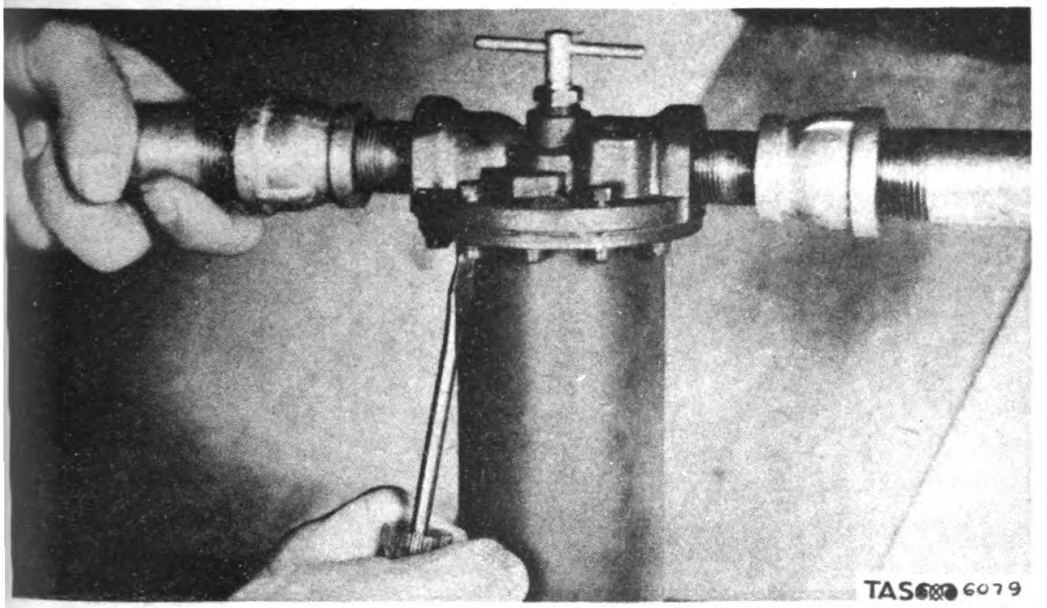

Fig. 79. Loosening Screws Under Rim and Top of Sump Assembly.

b. Pump. (See fig. 25.) (1) To remove from system and disassemble.

1. Remove belt guard from frame of generator.	1. Open-end wrench.
2. Remove bolts holding pump to equipment from bracket.	2. Open-end wrench.
3. Break water line at unions	3. Pipe wrenches.

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PROCEDURE	TOOLS
nearest pump. (See fig. 80.)	
4. Remove pump and fittings from system, lifting up so as to free pulley from drive belt.	4. Hand.
5. Remove fittings from pump.	5. Pipe wrenches.
6. Remove hexagonal head cap screws and pull apart the faceplate, the flanged bearing bushing cams, the case, and the left and right hand spiral cams and shafts.	6. Open-end wrench.
7. Remove all cap screws from backplate and free the packing box housing. Remove all bolts and studs so as to disassemble remaining parts as shown in figure 25.	7. Open-end wrench.
(2) To assemble and attach to system.	
1. Replace parts in the order shown in figure 25. Tighten all nuts.	1. Open-end wrenches as needed.
2. Attach pipe fittings to pump and pump to system, tightening unions. Re-attach	2. Open-end wrenches and pipe wrenches.

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PROCEDURE	TOOLS
pump to equipment frame bracket. Replace belt guard.	

c. Accumulator. (See fig. 26.) (1) To remove from system and disassemble.

1. Unscrew 1/2" union at base of accumulator, loosen and remove 1/2" close nipple holding accumulator to pipe. (See fig. 80.)	1. Pipe wrenches.
2. Remove accumulator tank from system.	2. Hand.
3. Loosen upper and lower arm assemblies.	3. Pipe wrench or crescent wrench.
4. Remove arm assemblies and glass gage assembly from accumulator tank.	4. Hand.
5. Disassemble glass gage assembly by loosening upper and lower glass nuts and pulling components apart.	5. Open-end wrenches.
6. Disassemble arm assemblies by loosening upper and lower packing nuts, and upper and lower head washer screws, and pulling components apart.	6. Open-end wrenches and screwdriver.

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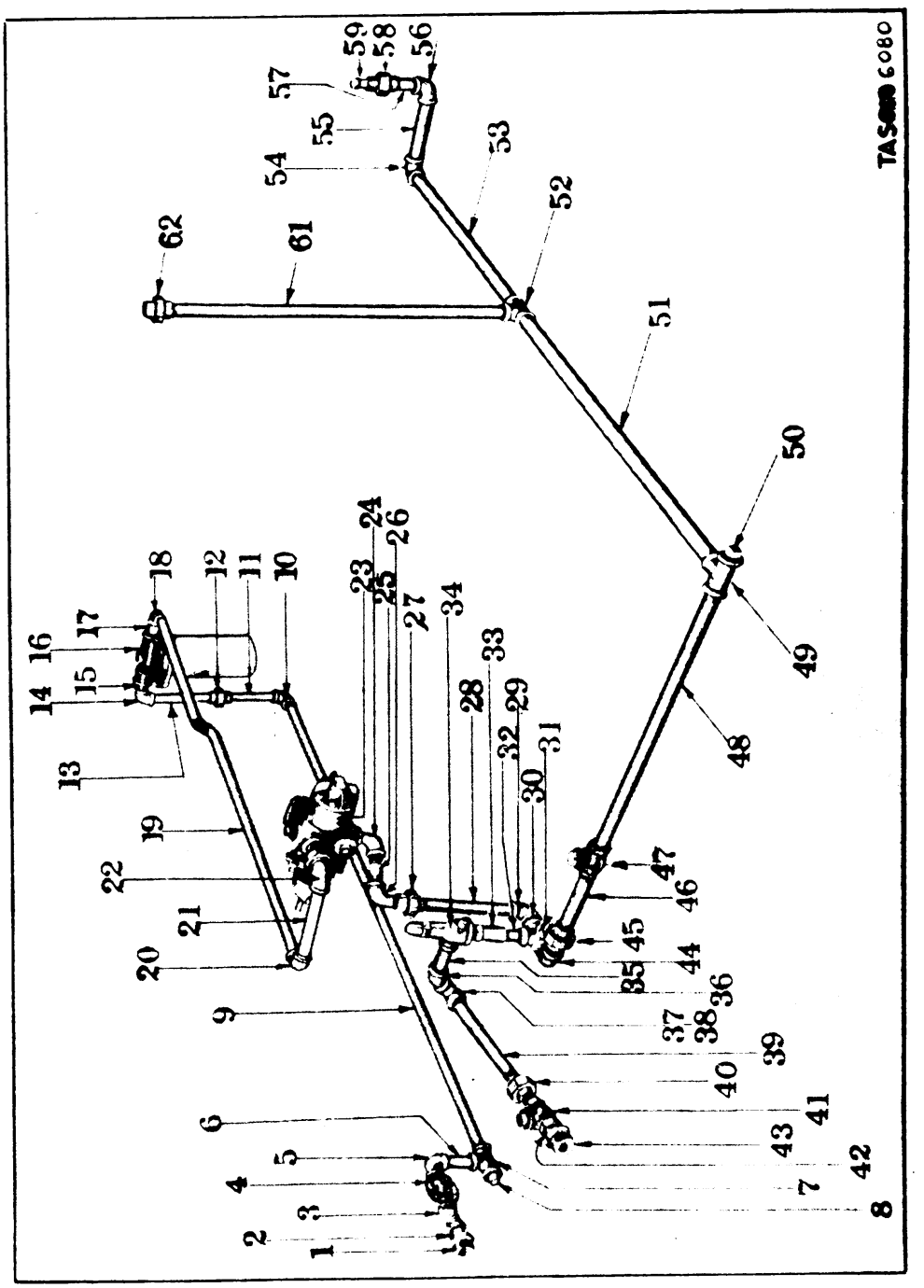

Fig. 80. Pipe Fittings on Water Suction, Discharge, Accumulator Extension, and Return Lines.

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1. Bushing - 1" x 1/2"
2. Nipple - Close, 1/2"
3. Valve - Gate, 1/2"
4. Union - M & F, 1/2"
5. Elbow - Street, 1/2"
6. Nipple - 1/2" x 3"
7. Tee - 1/2"
8. Plug - 1/2"
9. Nipple - 1/2" x 50"
10. Elbow - 1/2"
11. Nipple - 1/2" x 5"
12. Union - 1/2"
13. Nipple - 1/2" x 6-1/4"
14. Elbow - 1/2"
15. Nipple - Close, 1/2"
16. Filter - Water, 1/2"
17. Nipple - 1/2" x 2"
18. Elbow - 1/2"
19. Nipple - 1/2" x 43-1/4"
20. Elbow - 1/2"
21. Nipple - 1/2" x 6-1/2"
22. Elbow - Union, M & F, 1/2"
23. Pump - Water
24. Elbow - Street, 1/2"
25. Nipple - 1/2" x 2"
26. Elbow - Street, 1/2"
27. Union - 1/2"
28. Nipple - 1/2" x 6-1/2"
29. Elbow - 1/2"
30. Nipple - Short, 1/2"
31. Tee - 1/2"
32. Nipple - 1/2" x 2"
33. Coupling - 1/2"
34. Valve - Relief, 1/2"
35. Nipple - 1/2" x 3"
36. Elbow - Street, 1/2", 45°
37. Tee - 1/2"
38. Plug - 1/2"
39. Nipple - 1/2" x 8-1/4"
40. Union - 1/2", M & F
41. Valve - Swing check, 1/2"
42. Nipple - Close, 1/2"
43. Bushing - 1" x 1/2"
44. Elbow - Street, 1/2"
45. Union - M & F, 1/2"
46. Nipple - 1/2" x 5-1/2"
47. Valve - Check swing, 1/2"
48. Nipple - 1/2" x 19-3/4"
49. Tee - 1/2"
50. Plug - 1/2"
51. Nipple - 1/2" x 29-1/4"
52. Tee - 1/2"
53. Nipple - 1/2" x 21-1/2"
54. Elbow - 1/2"
55. Nipple - 1/2" x 5"
56. Elbow - 1/2"
57. Nipple - 1/2" x 2-1/2"
58. Union - 1/2"
59. Nipple - Close, 1/2"
61. Nipple - 1/2" x 22"
62. Union - 1/2"

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PROCEDURE	TOOLS
7. Loosen and remove petcock.	7. Hand or pliers.

(2) To assemble and attach to system.

1. Screw upper and lower valve gage bodies into accumulator tank.	1. Hand.
2. Assemble arm assemblies. by replacing parts in this order: insert valve gage stems in upper and lower valve gage bodies; replace head washer screws, iron gage wheels, and packing nuts on outer ends of upper and lower stems.	2. Open-end wrenches and screwdriver.
3. Assemble glass gage assembly by replacing parts in this order: put upper and lower brass washers inside upper and lower rubber washers; place rubber washers inside upper and lower glass nuts. Place glass nuts on appropriate threads of upper and lower gage bodies; insert glass gages in valve gage bodies and tighten nuts.	3. Open-end wrenches.
4. Insert petcock in lower gage body.	4. Hand and pliers.

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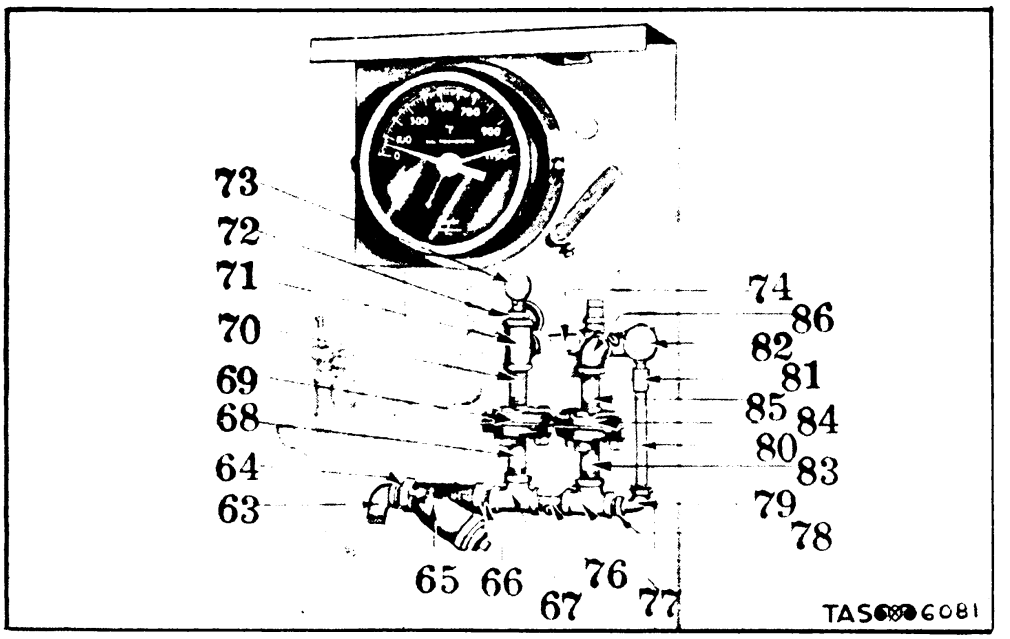

Fig. 81. Pipe Fittings on Front Portion of Water Manifold.

63. Elbow - Street, 1/2"
64. Nipple - Close, 1/2"
65. Strainer - 1/2"
66. Nipple - Close, 1/2"
67. Tee - 1/2"
68. Nipple - 1/2" x 2-1/2"
69. Union (orifice) - Flanged, 1/2"
70. Nipple - 1/2" x 2-1/2"
71. Tee - 1/2"
72. Bushing - 1/2" x 1/4"
73. Gage - Coil Pressure
74. Nipple - 1/2" x 7-1/2"
76. Nipple - 1/2" x 2"
77. Tee - 1/2"
78. Bushing - 1/2" x 1/4"
79. Elbow - Street, 1/4"
80. Nipple - 1/4" x 5"
81. Coupling - 1/4"
82. Gage - Water Pressure
83. Nipple - 1/2" x 2-1/2"
84. Union (orifice) - Flanged, 1/2"
85. Nipple - 1/2" x 2-1/4"
86. Elbow - 1/2"

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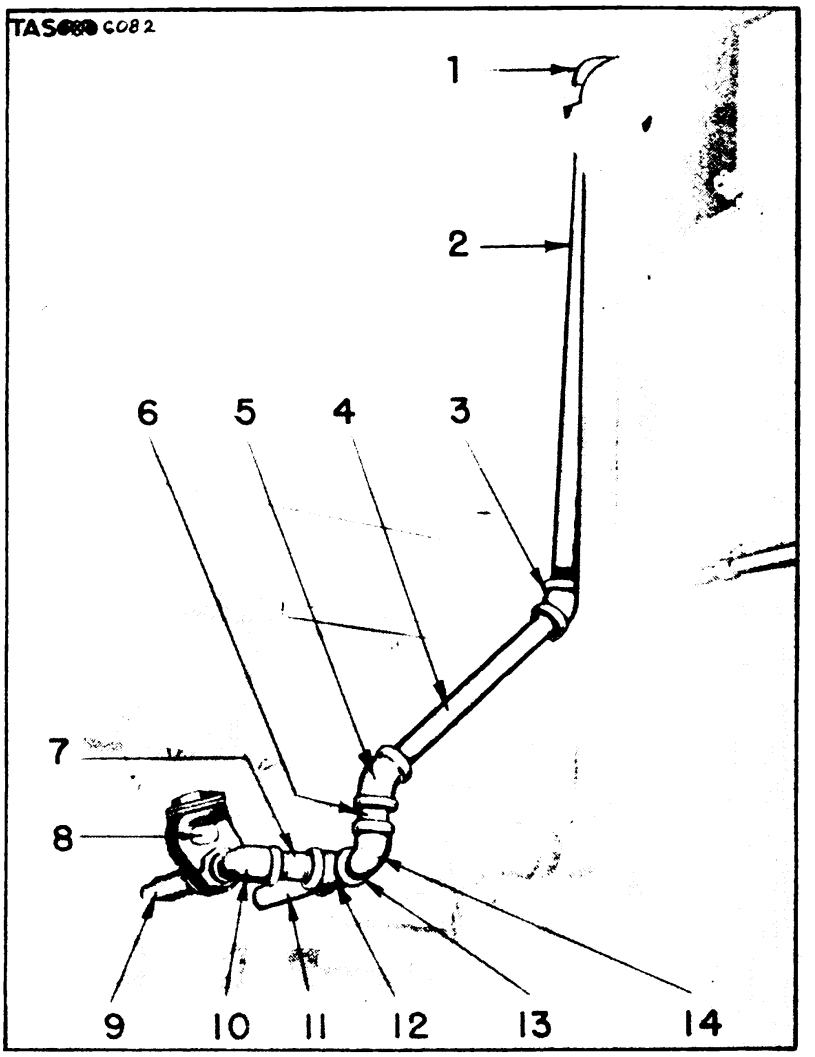

1. Elbow - Union, 1/2"
2. Nipple - 1/2" x 16-1/2"
3. Elbow - 1/2", 45°
4. Nipple - 1/2" x 9-1/2"
5. Elbow - 1/2", 45°
6. Close - 1/2"
7. Nipple - 1/2" x 2"
8. Valve - Quick-opening, 1/2"
9. Nipple - 1/2" x 5-1/2"
10. Elbow - Street, 1/2"
11. Nipple - 1/2" x 7-1/2"
12. Tee - 1/2"
13. Close - 1/2"
14. Elbow - 1/2"

Fig. 82. Pipe Fittings on Rear Portion of Water Manifold.

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PROCEDURE	TOOLS
5. Attach accumulator tank to nipple and tighten union.	5. Pipe wrenches.

d. Orifices. (See fig. 27.) (1) To remove from system and disassemble.

1. Remove bolts holding flanges together. This action exposes orifices.	1. Open-end wrench.
2. Pull out orifices.	2. Hand.

(2) To assemble and attach to system. Place orifices between flanges and bolt flanges together.

e. Discharge line check valve. (See figs. 18 and 23.)

1. Remove floor plate as directed in paragraph 26 a.	1. Screwdriver.
2. Disconnect discharge line at 1/2" M. & F. union on pump side of valve, and twist loose line carrying valve at 1/2" tee on accumulator side of valve. (See fig. 80.)	2. Pipe wrenches.
3. Remove nipples from valve body.	3. Pipe wrenches.
4. Disassemble and assemble in same manner as special oil system check valve. Then attach to system.	4. Tools as needed.

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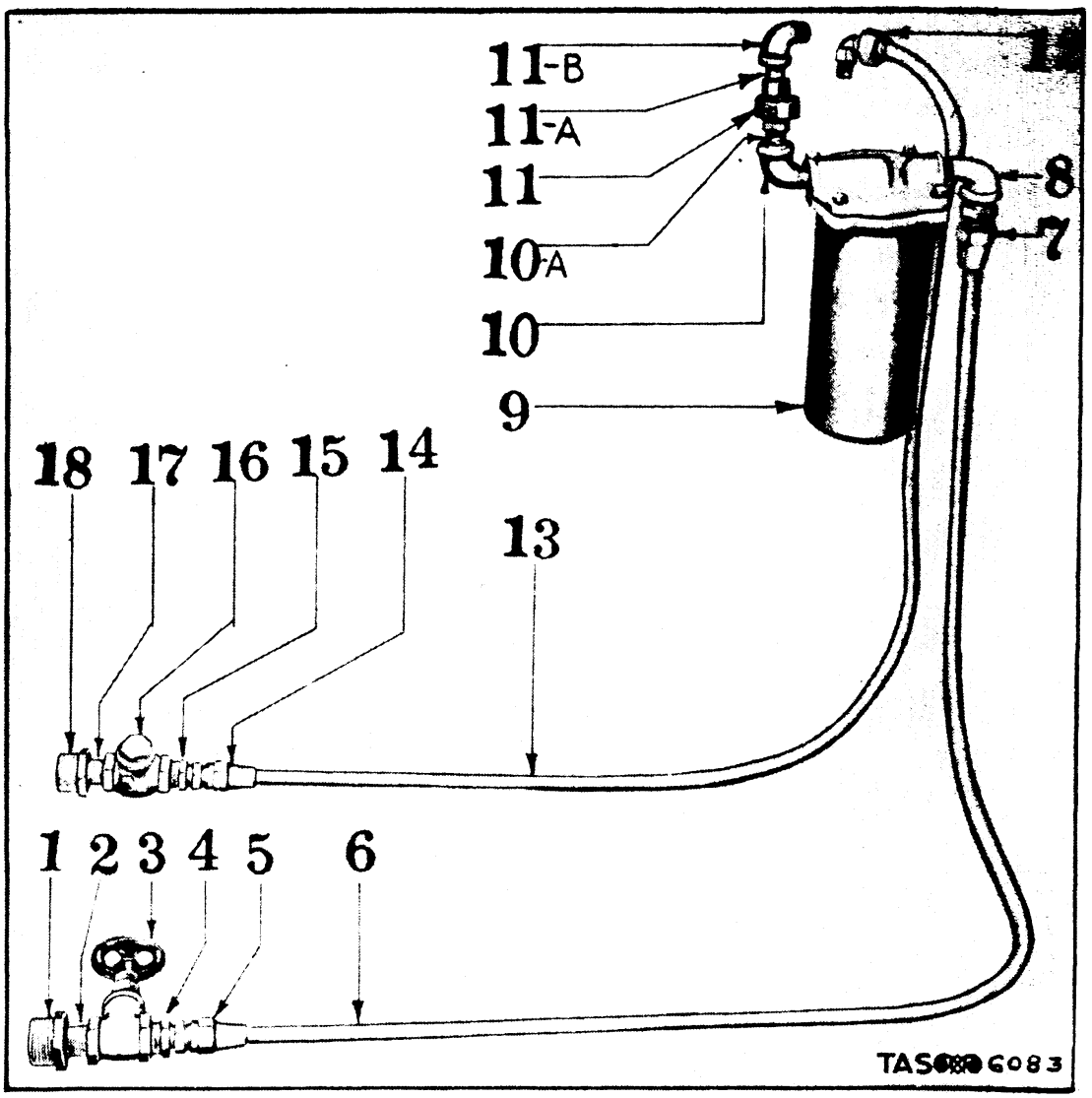

Fig. 83. Pipe Fittings on Fuel Oil System.

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1. Bushing - 1" x 1/2"
2. Nipple - Close, 1/2"
3. Valve - Gate, 1/2" (Crane)
4. Bushing - 1/2" x 3/8"
5. Adapter - Copper tube and nut, 3/8" x 1/2" O.D.
6. Tubing - Copper, 50" of 1/2" O.D.
7. Adapter - Straight, 3/8" x 1/2"
8. Elbow - Street, 3/8"
9. Filter - Oil, 3/8"
10. Elbow - Street, 3/8"
10a. Nipple - Close, 3/8"
11. Union - Male, 3/8"
11a. Nipple - Close, 3/8"
11b. Elbow - Street, 3/8"
12. Adapter - Elbow and nut, 3/8" x 1/2" O.D.
13. Tube - Copper, 1/2" O.D., 43" long
14. Adapter - Straight, 3/8" x 1/2" O.D.
15. Bushing - 3/8" x 1/2"
16. Valve - Swing check, 1/2" (Crane)
17. Nipple - Close, 1/2"
18. Bushing - 1" x 1/2"

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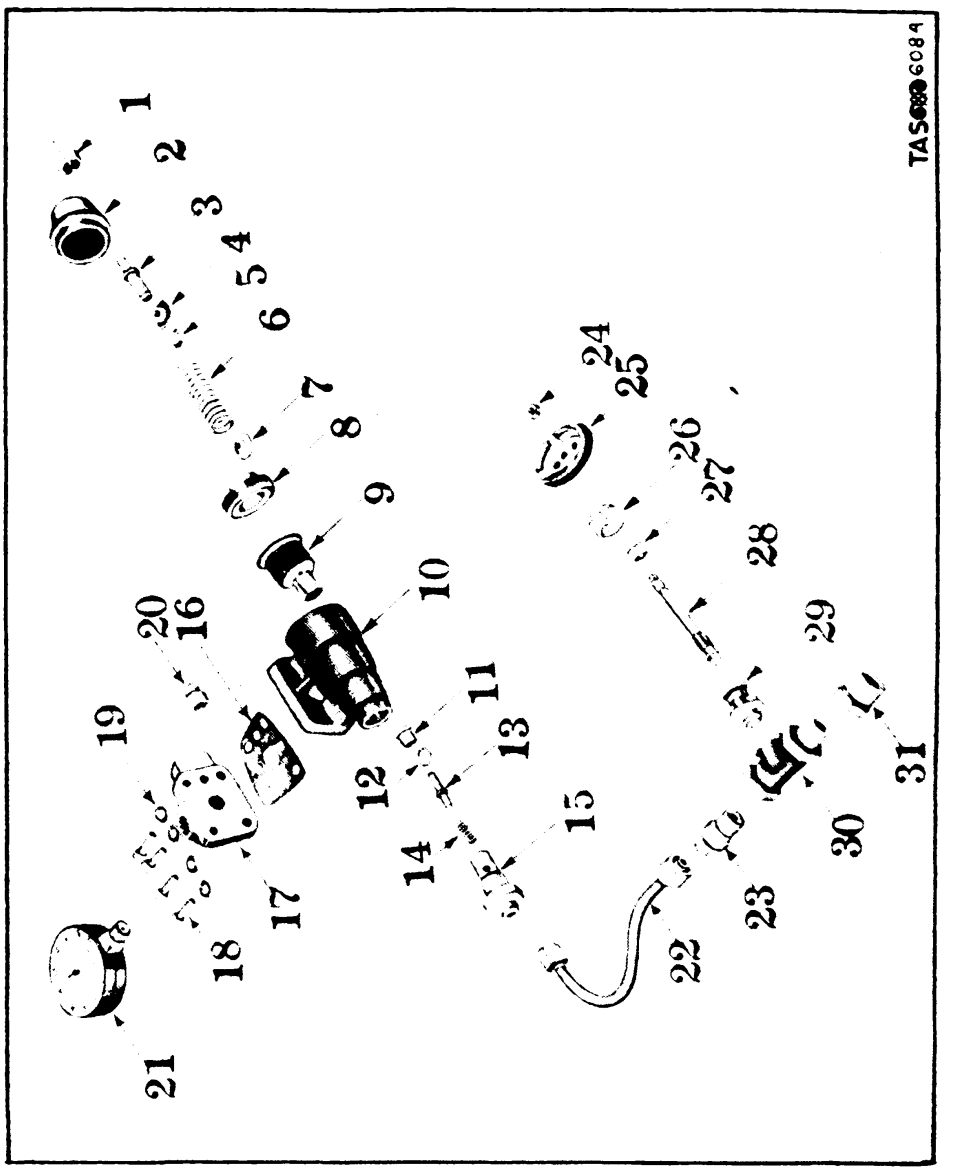

Fig. 84. Burner Fuel Line and Valve Parts Disassembled.

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Pressure regulating valve assembly parts:

1. Nut.
2. Cap.
3. Stem.
4. Fitting.
5. Lock.
6. Spring.
7. Washer.
8. Base.
9. Valve.
10. Body.
11. Seat.
12. Gasket.
13. Stem.
14. Spring.
15. Seat.
16. Valve gasket.
17. Valve fitting.
18. Fastening screw.
19. Washers.
20. Pipe plug.

Other parts:

21. Pressure gage.
22. Fuel oil outer discharge tubing.
23. Compression coupling.
31. Close nipple.

Shut-off valve:

24. Wheel nut.
25. Hand wheel.
26. Stuff nut.
27. Follower.
28. Stem.
29. Seat.
30. Body.

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PROCEDURE	TOOLS
5. Replace floor plate on generator.	5. Screwdriver.

f. Relief valve. (See fig. 17.)

1. Remove floor plate. (See par. 26 a.)	1. Screwdriver.
2. Disassemble and assemble valve in the same manner as special oil relief valve.	2. Tools as needed.

28. DISASSEMBLY - FUEL OIL SYSTEM. a. Pressure regulating valve. (See fig. 31.) (1) To remove from system and disassemble.

PROCEDURE	TOOLS
1. Loosen adapter nut and elbow and disconnect return line near top of pressure regulating valve. (See fig. 85.)	1. Crescent wrench.
2. Remove outer discharge tubing by loosening adapter nuts at base of pressure regulating valve and at entrance to shut-off valve. (See fig. 86.)	2. Open-end wrench.
3. Remove pressure gage by unscrewing it from system.	3. Crescent wrench.

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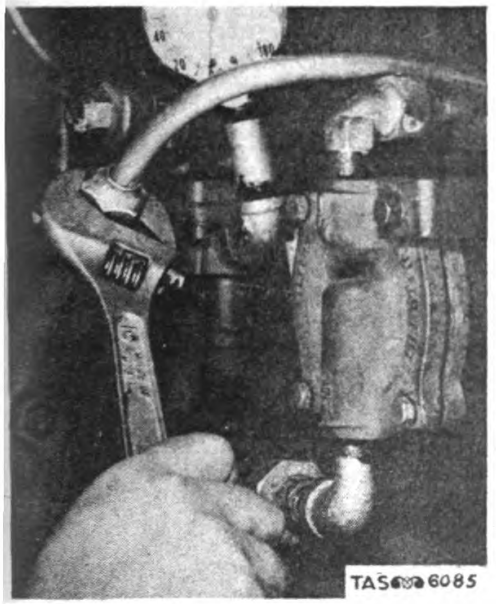

Fig. 85. Loosening Adapter Nut and Elbow and Disconnecting Return Line Near Top of Pressure Regulating Valve.

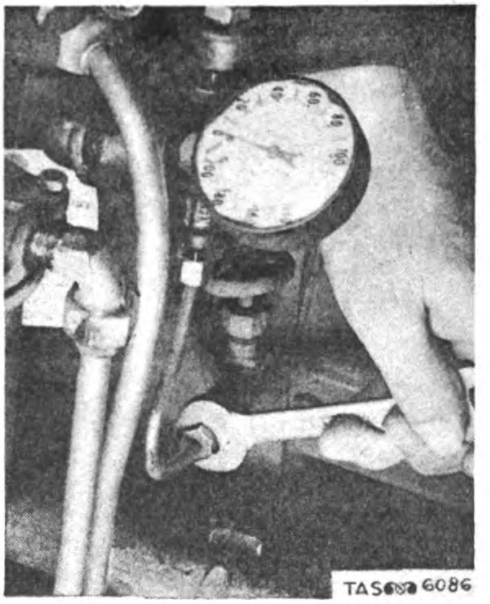

Fig. 86. Removing Outer Discharge Tubing by Loosening Adapter Nuts at Base of Pressure Regulating Valve.

PROCEDURE	TOOLS
4. Remove street elbow adapter to which fuel oil return line was attached before it was disconnected. (See fig. 87.)	4. Crescent wrench.
5. Remove valve assembly. Do this by placing jaws of wrench about valve body and twisting it loose. (See fig. 88.)	5. Pipe wrench.

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PROCEDURE	TOOLS
6. Remove valve cap by loosening top nut.	6. Open-end wrench.
7. Loosen and remove all components from body of valve.	7. Hand and open-end wrench.

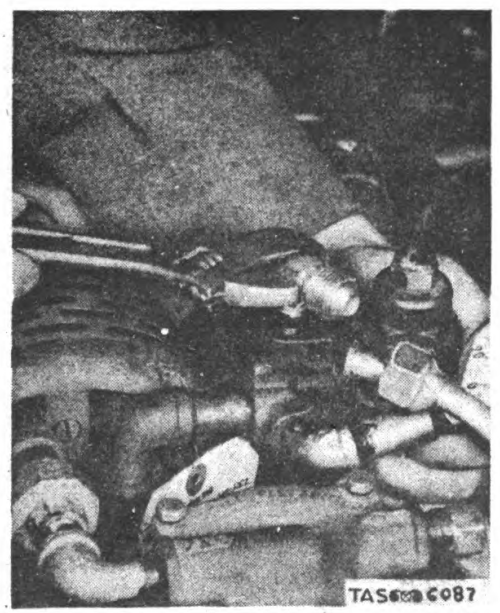

Fig. 87. Removing Street Elbow Adapter to Which Fuel Oil Return Line Was Attached Before It Was Disconnected.

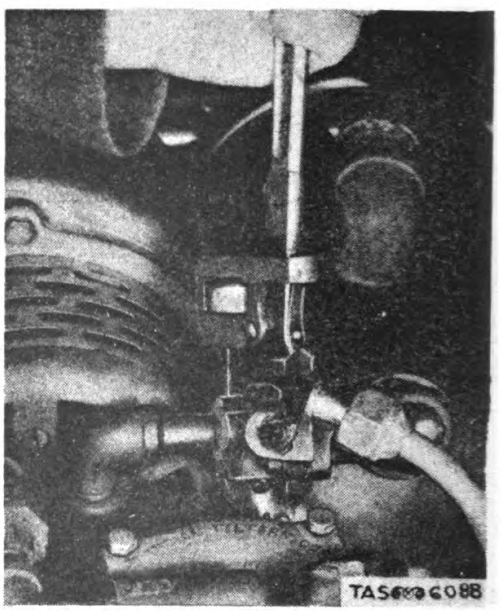

Fig. 88. Removing valve Assembly.

(2) To assemble and attach to system.

1. Replace parts in valve body in this order: replace base on valve and insert valve	1. Open-end wrench and hand.

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PROCEDURE	TOOLS
in body; replace washer in base; insert stem, fitting, and lock in spring; insert spring in base; replace and tighten cap.	
2. Attach valve assembly to system.	2. Pipe wrenches.
3. Replace return line street adapter ell.	3. Crescent wrench.
4. Replace pressure gage.	4. Crescent wrench.
5. Reconnect return line.	5. Crescent wrench.
6. Replace outer discharge tubing.	6. Open-end wrench.

(Note: Variations in these procedures resulting from the installation of reduced capacity jump-overs from the fuel line to the fog line at the manifold are discussed in Appendix IV. These differences apply to some models of the smoke generator, M1.)

b. Shut-off valve. (See fig. 32.) This valve is disassembled in much the same manner as the fixed needle valve on the special oil manifold. Note that the stem inserts immediately into the seat, with the packing gland, stuff nut, hand-wheel, and wheel nut fitting onto the stem in that order. As previously pointed out, a key usually takes the place of the hand-wheel on magneto-ignition model generators.

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PROCEDURE	TOOLS
c. Burner fan assembly. (See fig. 36.) (1) To remove from system and disassemble.	
1. Disconnect fuel oil return line, remove outer discharge tubing, and remove fuel oil pressure gage - all as directed in paragraph 28 a.	1. Crescent wrench, open-end wrenches.
2. Remove bolts holding guard and pump assembly to fan housing. (See fig. 89.)	2. Open-end wrench.
3. Remove guard and pump assembly.	3. Hand.
4. Remove rubber coupling inside fan housing. (See fig. 90.)	4. Hand.

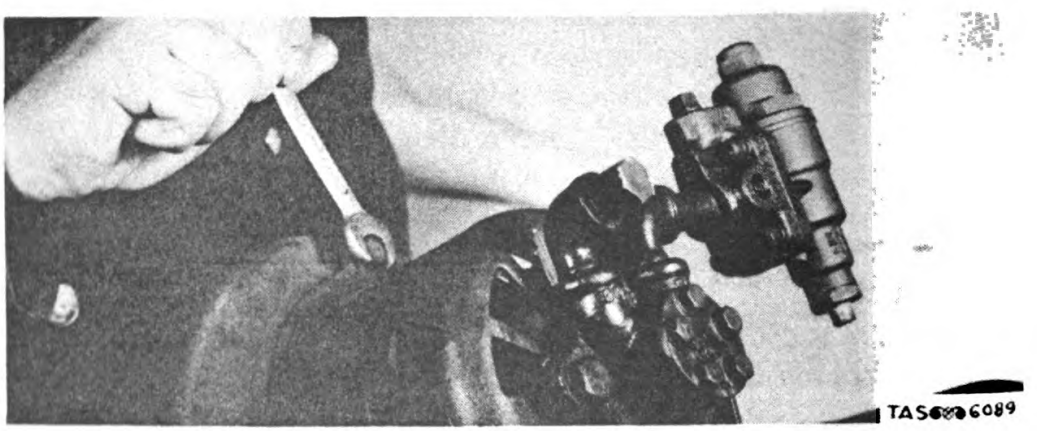

Fig. 89. Removing Bolts Holding Guard and Pump Assembly to Fan Housing.

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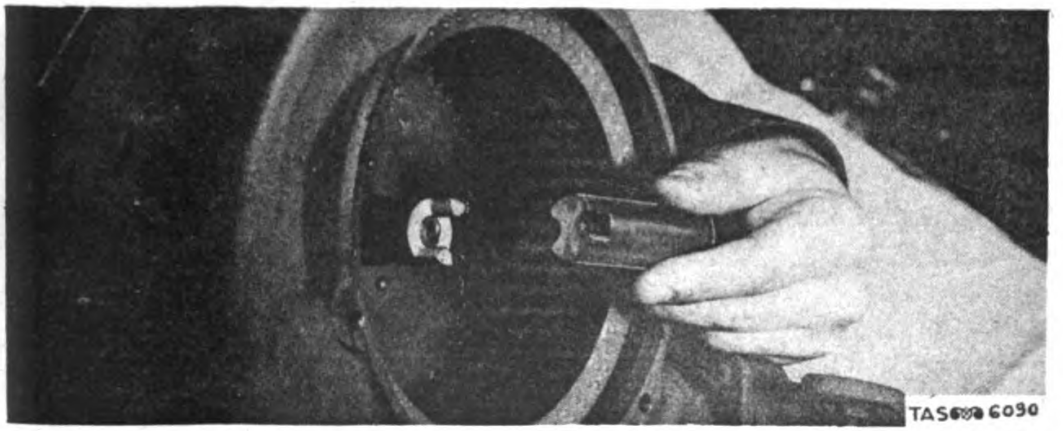

Fig. 90. Removing Rubber Coupling Inside Fan Housing.

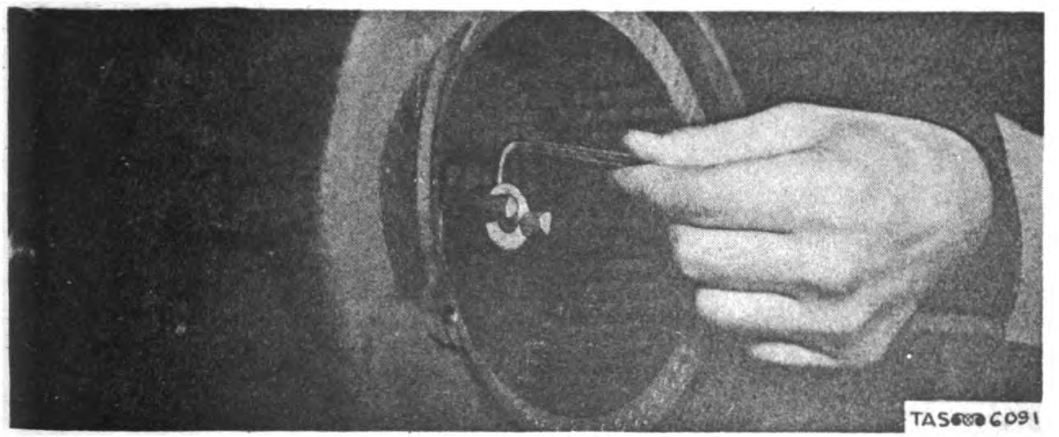

Fig. 91. Loosening Set Screw on Steel Part of Flexible Coupling and Removing One-half of Steel Part of Coupling.

PROCEDURE	TOOLS
5. Loosen set screw on steel part of flexible coupling and remove one-half of steel part of coupling. (See fig. 91.)	5. Allen wrench.

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PROCEDURE	TOOLS
6. Remove fan from flexible coupling.	6. Hand.

(2) To assemble and attach to system.

1. To replace fan, insert it in housing. Place it as near as possible at the center of housing.	1. Hand.
2. Place set screw hole of fan on FLAT portion of flexible coupling.	2. Hand.
3. Replace the detached half of the steel coupling, ALINING ALLEN SCREW HOLE WITH FLAT PART.	3. Hand.
4. Tighten set screw.	4. Allen wrench.
5. Stick rubber coupling into fork of steel coupling.	5. Hand.
6. Replace guard and pump assembly.	6. Open-end wrench.
7. Replace return line, pressure gage, and outer discharge tubing as directed in paragraph 28 a.	7. Crescent wrench and open-end wrenches.

d. Air tube and combustion head assembly. (See figs. 38 and 39.) (1) To disassemble.

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PROCEDURE	TOOLS
.. Remove screws holding cover of air tube. Remove air tube cover. This exposes combustion head assembly. (See fig. 92.)	1. Screwdriver.
2. Remove electrode wires from posts of electrode assemblies.	2. Hand.
3. Remove inner discharge tubing by loosening adapter nuts at either end. (See fig. 93.)	3. Open-end wrench.

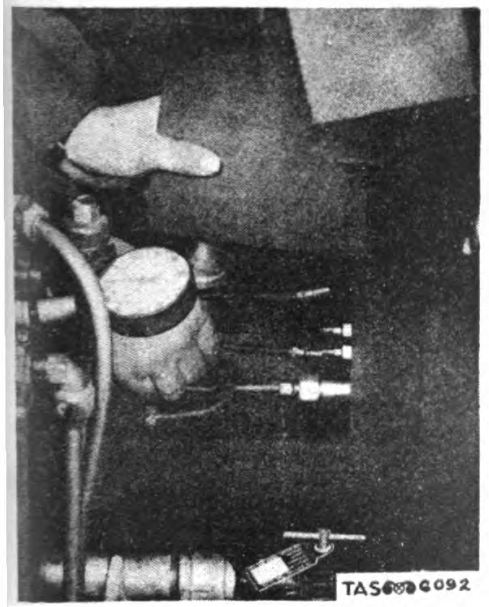

Fig. 92. Removing Air Tube Cover.

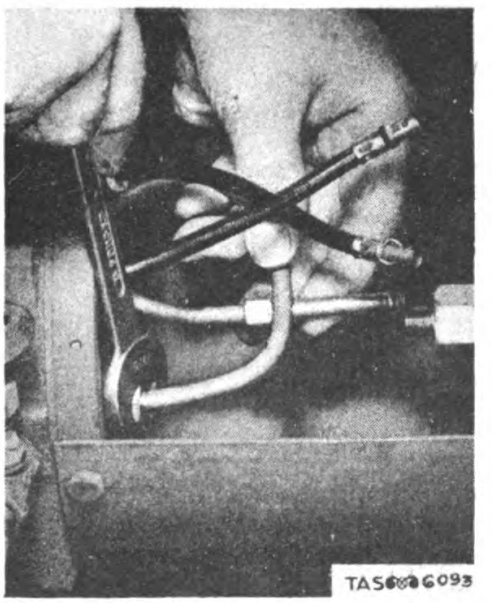

Fig. 93. Removing Inner Discharge Tubing by Loosening Adapter Nuts at Either End.

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PROCEDURE	TOOLS
4. Loosen bolt underneath air tube. This bolt holds combustion head assembly in air tube.	4. Open-end wrench.
5. Remove combustion head assembly from air tube. To do this, slide assembly toward fan end of tube, tipping it down toward the fan end. Then lift the combustion head end of the assembly out first. Remainder will follow. (See fig. 94.)	5. Hand.
6. Insert Allen wrench, as shown in figure 95, to loosen atomizing nozzle pipe from combustion head assembly. Remove nozzle pipe and body from assembly.	6. Allen wrench.
7. Place nozzle pipe in a vise and remove atomizing nozzles from body and shield with an open-end wrench. If vise is not available, operator can perform removal of nozzles by holding pipe with pipe wrench as shown in figure 96.	7. Vise (or pipe wrench) and open-end wrench.
8 Place nozzle in vise and remove core of nozzle	8. Vise (or crescent wrench) and screwdriver.

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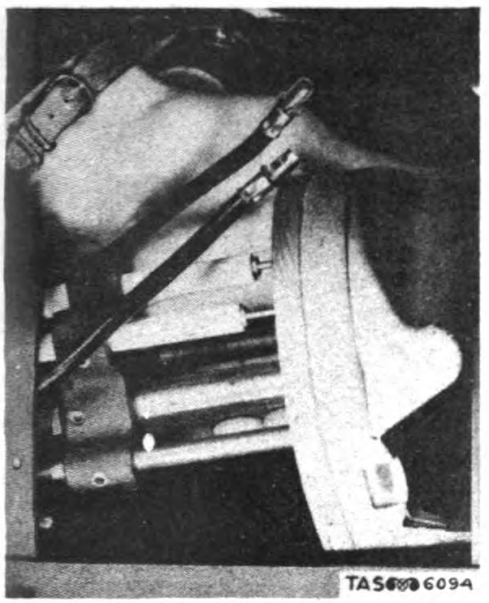

Fig. 94. Removing Combustion Head Assembly from Air Tube.

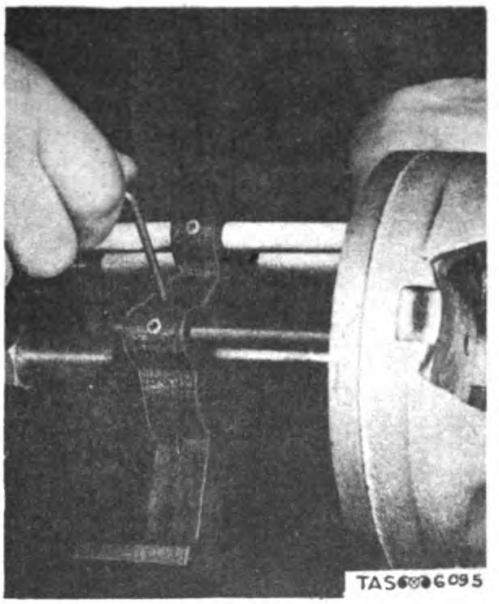

Fig. 95. Loosening Atomizing Nozzle Pipe from Combustion Head Assembly.

PROCEDURE	TOOLS
with screwdriver. If vise is not available, hold nozzle in a crescent wrench. DO NOT USE PIPE WRENCH. (See fig. 97.)	
9. Insert core in nozzle.	9. Hand.
10. Place nozzle in vise or crescent wrench, and tighten core.	10. Vise (or crescent wrench) and screwdriver.
11. Lay nozzle aside on a CLEAN spot.	11. Hand.

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PROCEDURE	TOOLS
12. Repeat steps 8, 9, 10, and 11 for other nozzle.	12. Tools as needed.
13. Holding nozzle pipe by means of a vise or pipe wrench, loosen the nozzle pipe connector nut. (See fig. 98.)	13. Vise (or pipe wrench) and open-end wrench.
14. Pull nozzle pipe screen from inside of nozzle pipe. (See fig. 99.)	14. Hand.

Fig. 96. Removing Nozzle.

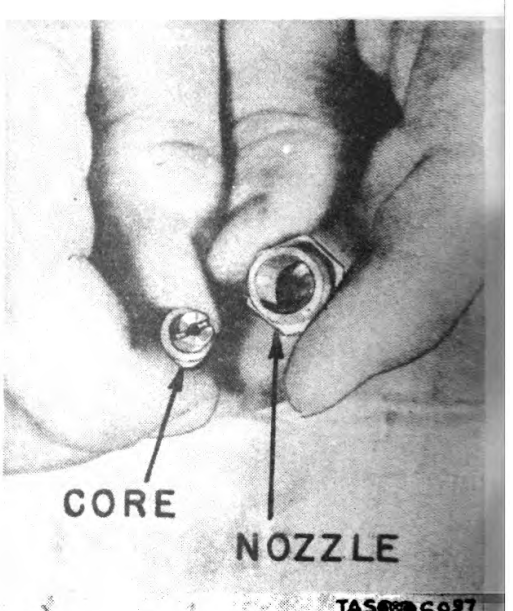

Fig. 97. Atomizing Nozzle and Core.

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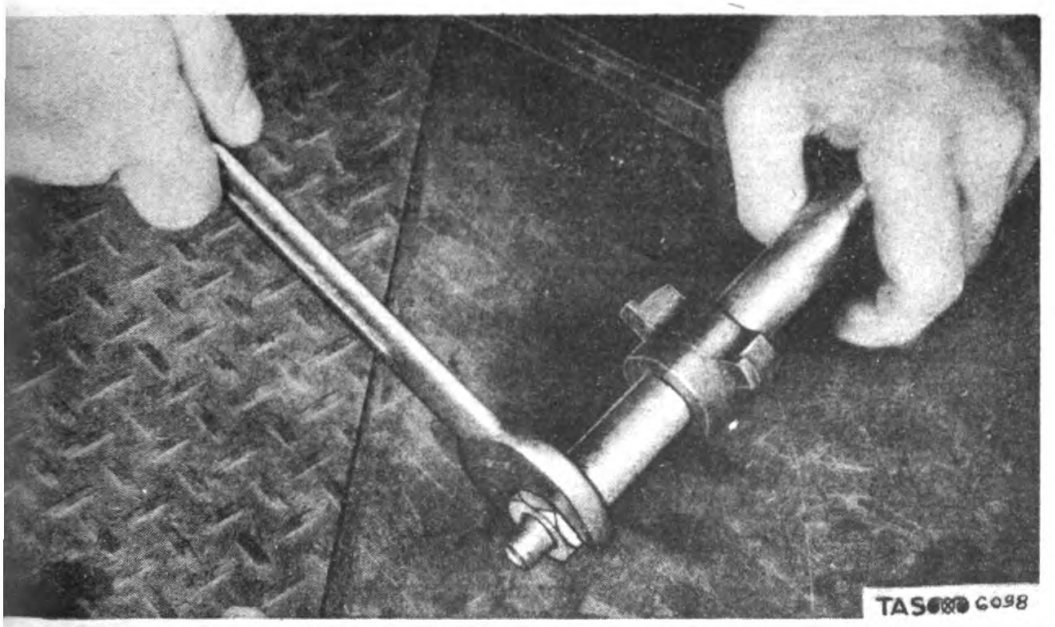

Fig. 98. Holding Nozzle Pipe by Means of Pipe Wrench and Loosening Nozzle Pipe Connector Nut.

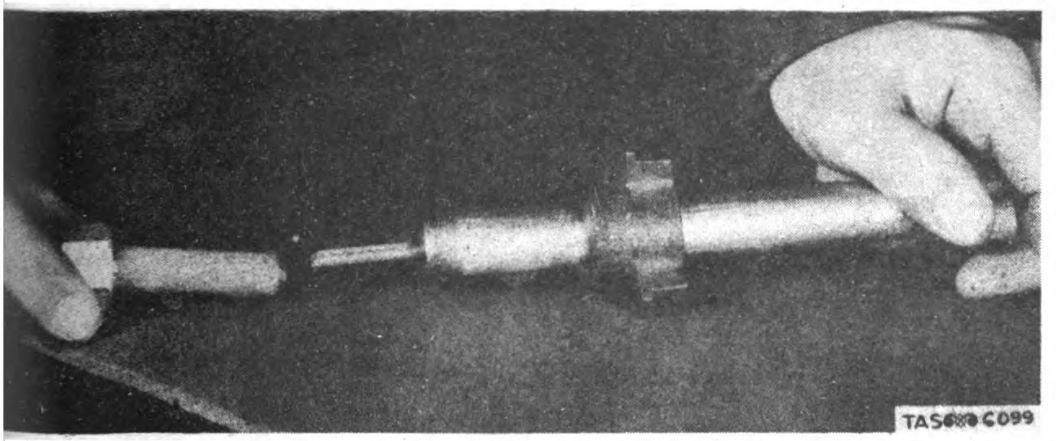

Fig. 99. Pulling Nozzle Pipe Screen from Inside of Nozzle Pipe.

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PROCEDURE	TOOLS
(2) To assemble.	
1. Replace screen. Replace nozzle pipe connector nut. Hold nozzle pipe in vise or pipe wrench and tighten connector nut with open-end wrench. Replace nozzles in nozzle shield and body, and tighten with open-end wrench. Replace nozzle pipe in combustion head assembly, tightening set screw with Allen wrench as shown in figure 95.	1. Tools as needed.
2. Wipe combustion head assembly clean and replace in air tube. Connect inner discharge tubing. Connect wires to posts of electrode assemblies. Tighten bolt underneath air tube. Replace air tube cover.	2. Tools as needed.
3. Start generator engine. Lift air tube cover to check for leaks inside. If no leaks develop, replace and tighten air tube cover screws.	3. Hand.
e. Fuel oil pump. (1) To remove from system.	
1. Disconnect fuel oil return	1. Crescent wrench and open-

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PROCEDURE	TOOLS
line and remove outer discharge tubing - both as directed in paragraph 28 a.	end wrenches.
. Disconnect suction line by loosening 3/8" street elbow on top of pump assembly.	2. Crescent wrench or open-end wrench.
. Remove two cap screws holding pump assembly to rest of pump and guard assembly. (See fig. 100.)	3. Open-end wrench.
. Remove pump assembly from rest of pump and	4. Hand.

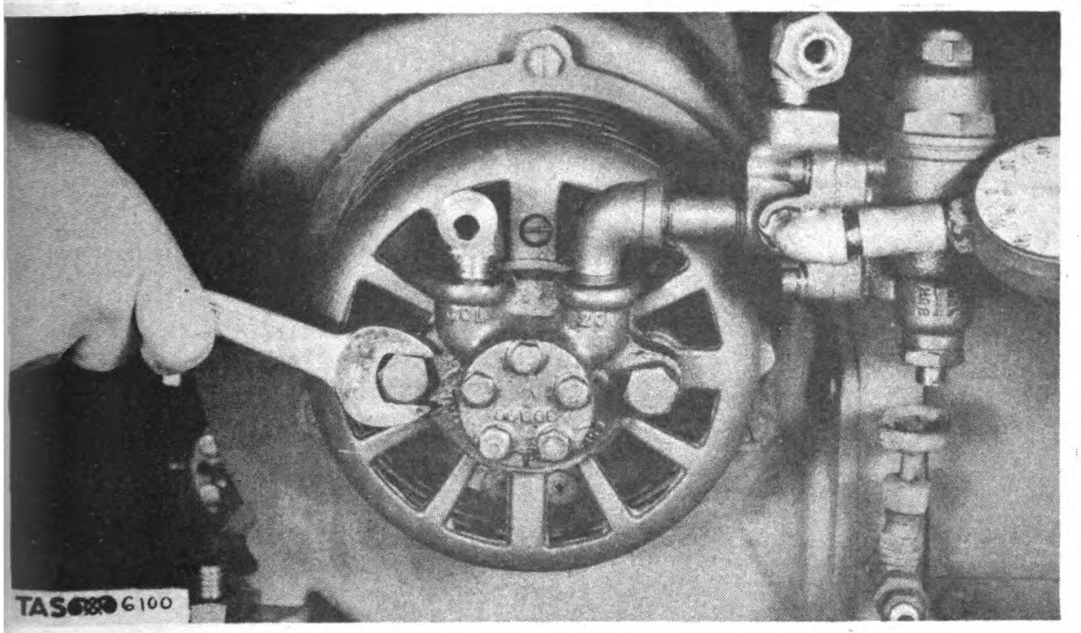

Fig. 100. Removing Two Cap Screws Holding Pump Assembly to Rest of Pump and Guard Assembly.

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PROCEDURE	TOOLS
guard assembly.	
5. Remove 3/8" street elbow from top of pump assembly. (See fig. 101.)	5. Open-end wrench.

(2) To attach pump assembly to system.

1. Bolt pump assembly to pump and guard assembly. Replace 3/8" street elbow on top of pump assembly and connect suction line to it. Replace outer discharge tubing. Connect return line.	1. Open-end wrenches.

29. DISASSEMBLY - HEATING SYSTEM. a. Coil assembly and spray nozzle manifold. (See fig. 42.) To remove from furnace.

PROCEDURE	TOOLS
1. Remove separable bushing, gasket, and tube system from center of spray nozzle manifold and take out the bulb of dial thermometer. (See fig. 102.)	1. Pipe wrenches.
2. Detach spray nozzle pressure gage piping from spray nozzle manifold by removing union and nipple. (See fig. 103.) On models	2. Pipe wrenches.

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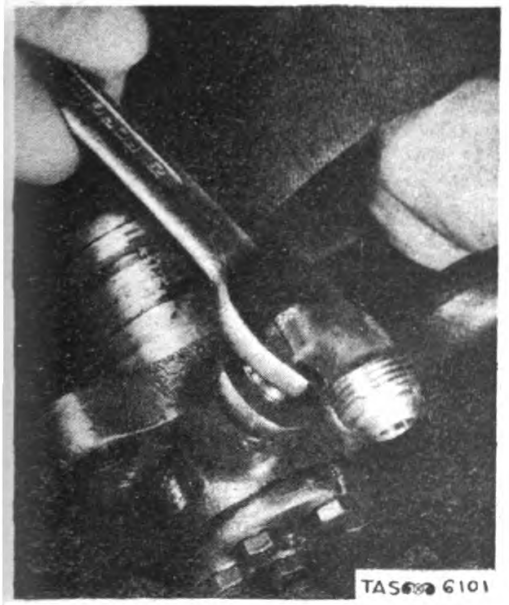

Fig. 101. Removing 3/8-Inch Street Elbow from Top of Pump Assembly.

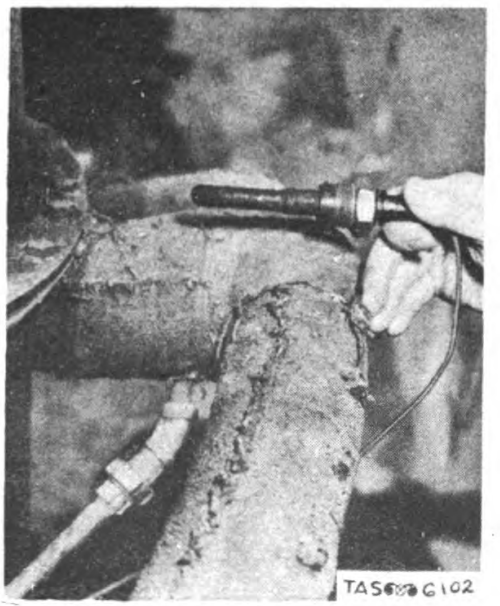

Fig. 102. Taking Out Instrument Bulb of Dial Thermometer.

PROCEDURE

TOOLS

of the smoke generator now being issued there is no spray nozzle pressure gage and piping. These models, also, are equipped with a thermometer bulb protective shield. This shield has to be removed before the thermometer bulb can be withdrawn and before the coils can be removed from the furnace. (See fig. 1.)

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Fig. 103. Detaching Spray Nozzle Gage Piping from Spray Nozzle Manifold by Removing Union and Nipple.

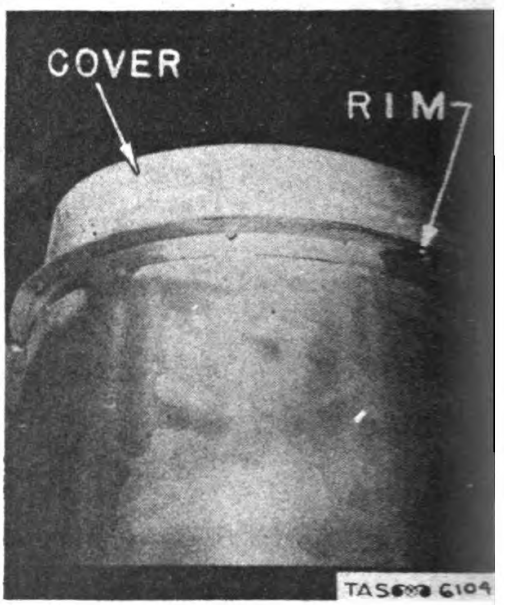

Fig. 104. Furnace Cover.

PROCEDURE	TOOLS
3. Remove all bolts from rim of furnace cover. (See fig. 104.)	3. Open-end wrench.
4. Break water manifold pipe at furnace by removing 1/2" union and 1/2" union elbow. (See fig. 82)	4. Pipe wrenches.
5. Break special oil manifold pipe at furnace by removing 1" union and 1" union	5. Pipe wrenches.

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PROCEDURE	TOOLS
elbow. (See fig. 78.)	
6. Remove furnace pipe inlet cover from furnace shell. (See fig. 105.)	6. Open-end wrench.
7. Attach hooks of tackel to coil assembly lifting hooks inside cover and lift coil assembly and spray nozzle manifold out of furnace.	7. Hoist, block and tackle.

b. Furnace. To remove the furnace from the generator, remove the coil assembly as directed in paragraph 29 a. To remove the burner combustion head assembly, remove the burner cover from the furnace shell by means of a screwdriver, and then release the furnace shell from the generator frame by removing the bolts holding it to the frame.

30. DISASSEMBLY - CONTROL SYSTEM. a. Engine. (See fig. 45.) (1) To remove from generator.

PROCEDURE	TOOLS
1. Remove gasoline tank from engine. (See fig. 106.)	1. Open-end wrench.
2. Remove belt guard from frame of generator and loosen bolt of pipe clamp nearest engine so as to free water pipe from engine.	2. Open-end wrench.
3. Disconnect all ignition	3. Open-end wrench, screw-

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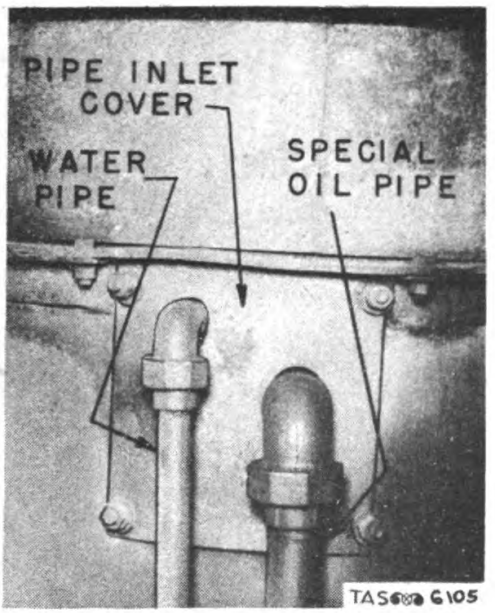

Fig. 105. Furnace Pipe Inlet Cover.

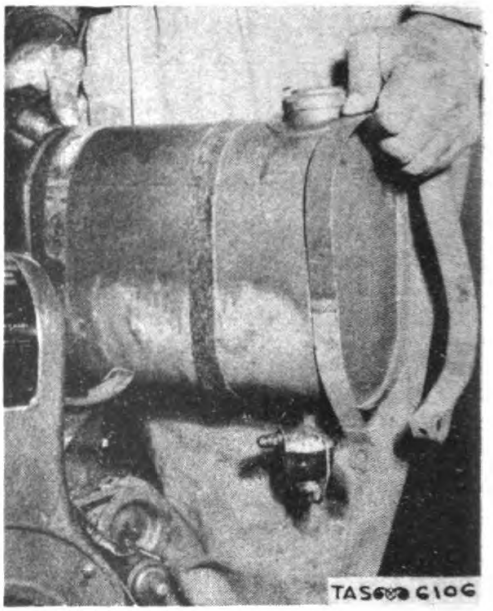

Fig. 106. Removing Gasoline Tank from Engine.

PROCEDURE	TOOLS
cables from the solenoid switch.	driver, and pliers.
4. Disconnect all ignition cables from the engine magneto.	4. Pliers.
5. Remove engine control panel. All cables attached to it are now loose and the panel and attached wires can be laid aside as one unit.	5. Open-end wrench.

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PROCEDURE	TOOLS
6. Remove main bearing plate cap screws from main bearing plate on take-off end of engine.	6. Open-end wrench.
7. Remove bolts holding engine to equipment frame platform.	7. Open-end wrench.
8. Remove engine from generator, sliding it free from take-off shaft.	8. Hand.

b. Engine connecting rod and piston. (See fig. 107.)

(1) To expose.

1. Remove control panel from engine. Do not detach wires.	1. Open-end wrench.
2. Disengage spark plug cable.	2. Hand.
3. Remove air shroud cover. (See fig. 111.)	3. Screwdriver.
4. Remove all cylinder head cap screws and remove cylinder head. (See fig. 112.)	4. Open-end wrench.
5. Remove carburetor mounting cap screws holding manifold to carburetor, and	5. Open-end wrench and screwdriver.

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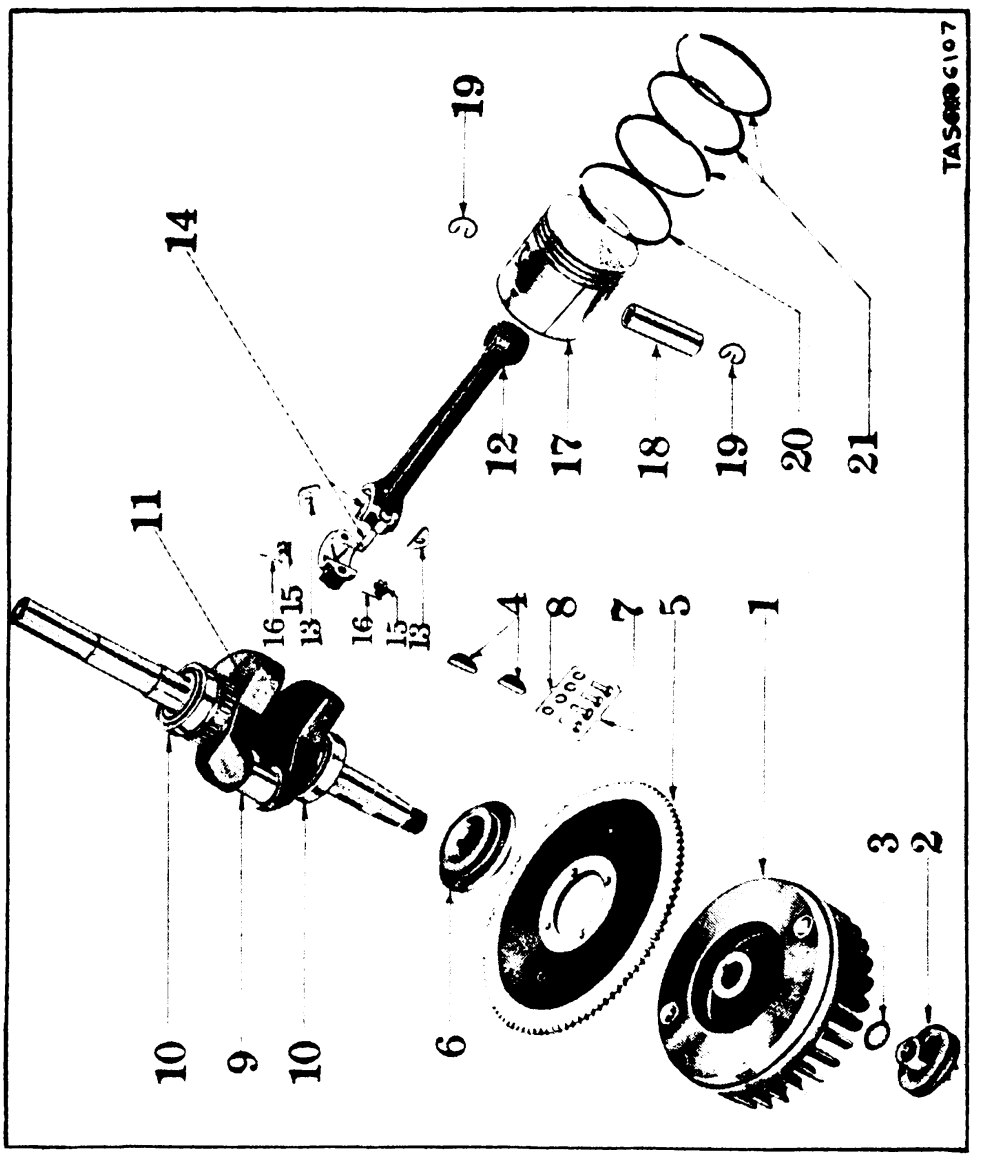

Fig. 107. Engine Crankshaft, Connecting Rod, Piston, and Flywheel.

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1. Flywheel.
2. Starting rope sheave.
3. Washer.
4. Woodruff key for flywheel and gear.
5. Large starter gear.
6. Pulley for generator drive.
7. Screws for generator drive pulley.
8. Lock washers for generator drive pulley.
9. Crankshaft.
10. Main bearing.
11. Crankshaft gear
12. Connecting rod with cap.
13. Bearing shim for connecting rod.
14. Connecting rod bolt.
15. Slotted nut for connecting rod.
16. Cotter pin for connecting rod bolt.
17. Piston.
18. Piston pin.
19. Piston pin retaining ring.
20. Oil regulating piston ring.
21. Compression piston rings.

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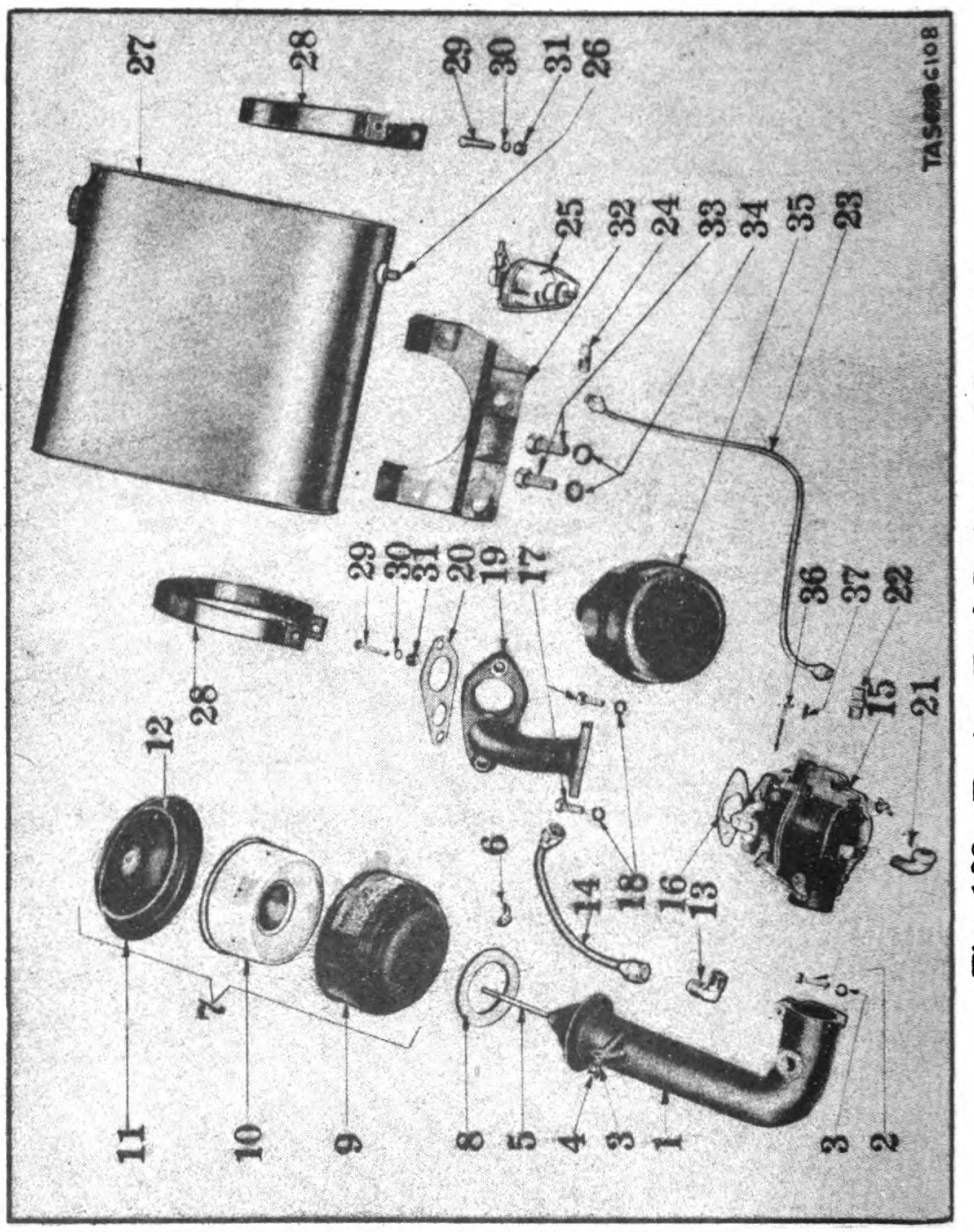

Fig. 108. Engine Fuel System and Exhaust.

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1. Air cleaner bracket.
2. Bracket screw for air cleaner.
3. Lock washers for air cleaner bracket.
4. Cap screw for air cleaner brace.
5. Air filter stud.
6. Wing nut for air filter.
7. Oil bath air cleaner assembly.
8. Gasket.
9. Body.
10. Filter.
11. Top cap.
12. Gasket.
13. Breather lining fitting.
14. Breather line.
15. Carburetor.
16. Gasket.
17. Cap screws for carburetor mounting.
18. Lock washers for carburetor mounting.
19. Intake manifold.
20. Gasket.
21. Street elbow for carburetor drip hole.
22. Fuel line fitting.
23. Fuel line.
24. Fuel line fitting.
25. Fuel strainer.
26. Nipple.
27. Gasoline tank.
28. Tank strap.
29. Screw.
30. Washer.
31. Nut.
32. Tank bracket.
33. Screws for tank strap.
34. Lock washer for tank strap.
35. Muffler.
36. Governor control rod.
37. Cotter pin for governor control lever.

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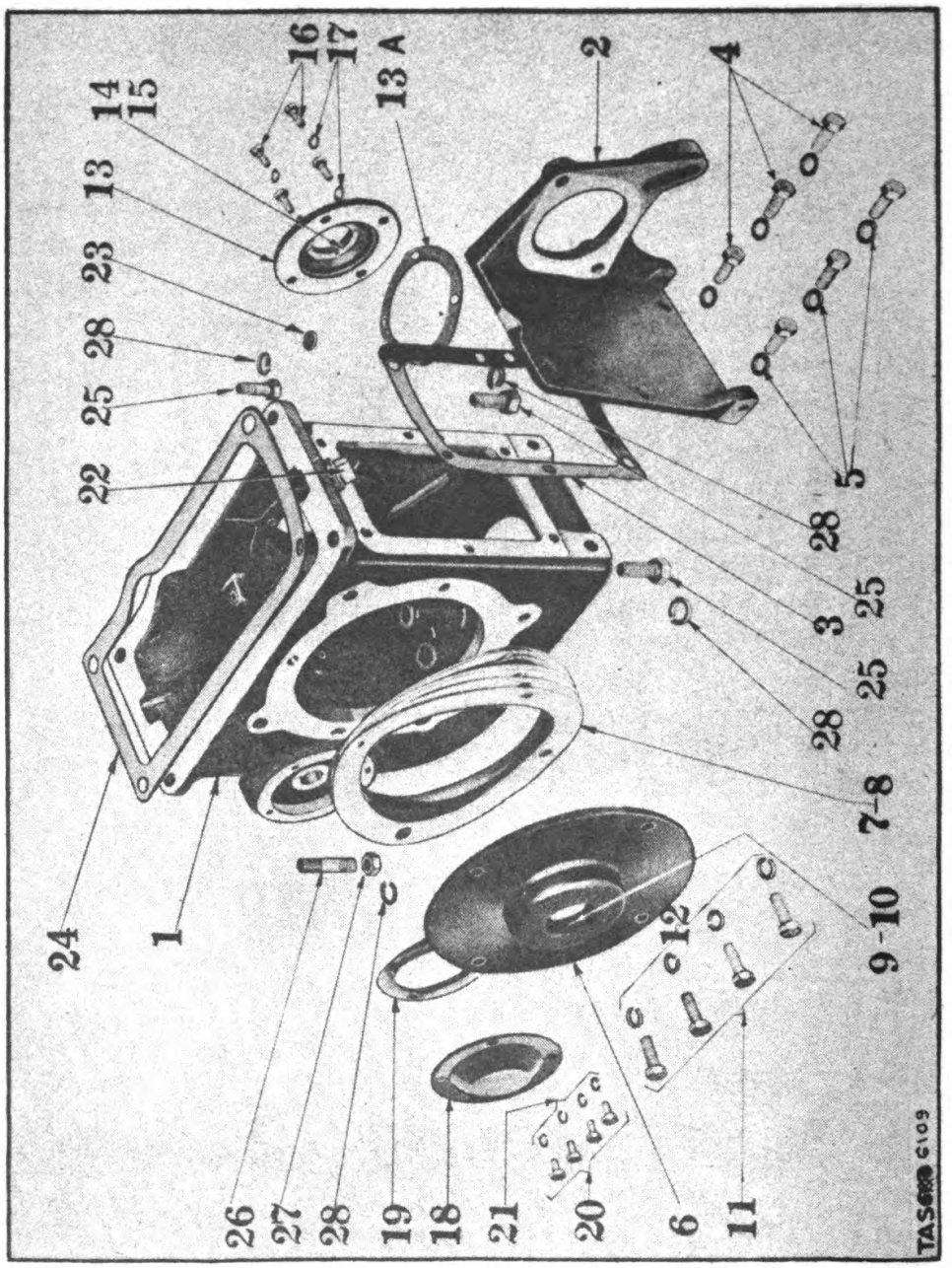

Fig. 109. Engine Crankcase.

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1. Crankcase.
2. Connecting rod inspection plate.
3. Gasket for connecting rod inspection plate.
4. Cap screws for connecting rod inspection plate.
5. Washer.
6. Main bearing plate, take-off end.
7. Gasket.
8. Gasket.
9. Washer.
10. Oil crankshaft oil seal retainer, take-off end.
11. Screws.
12. Washer.
13. Main bearing retainer plate, flywheel end.
13.A. Gasket.
14. Washer.
15. A crankshaft oil seal retainer, flywheel end.
16. Screw.
17. Lock washer.
18. Magneto gear cover plate.
19. Gasket.
20. Screw.
21. Lock washer.
22. Pipe plug.
23. Welch plug for camshaft pinhole.
24. Gasket.
25. Base screws.
26. Base studs.
27. Nut.
28. Lock washer.

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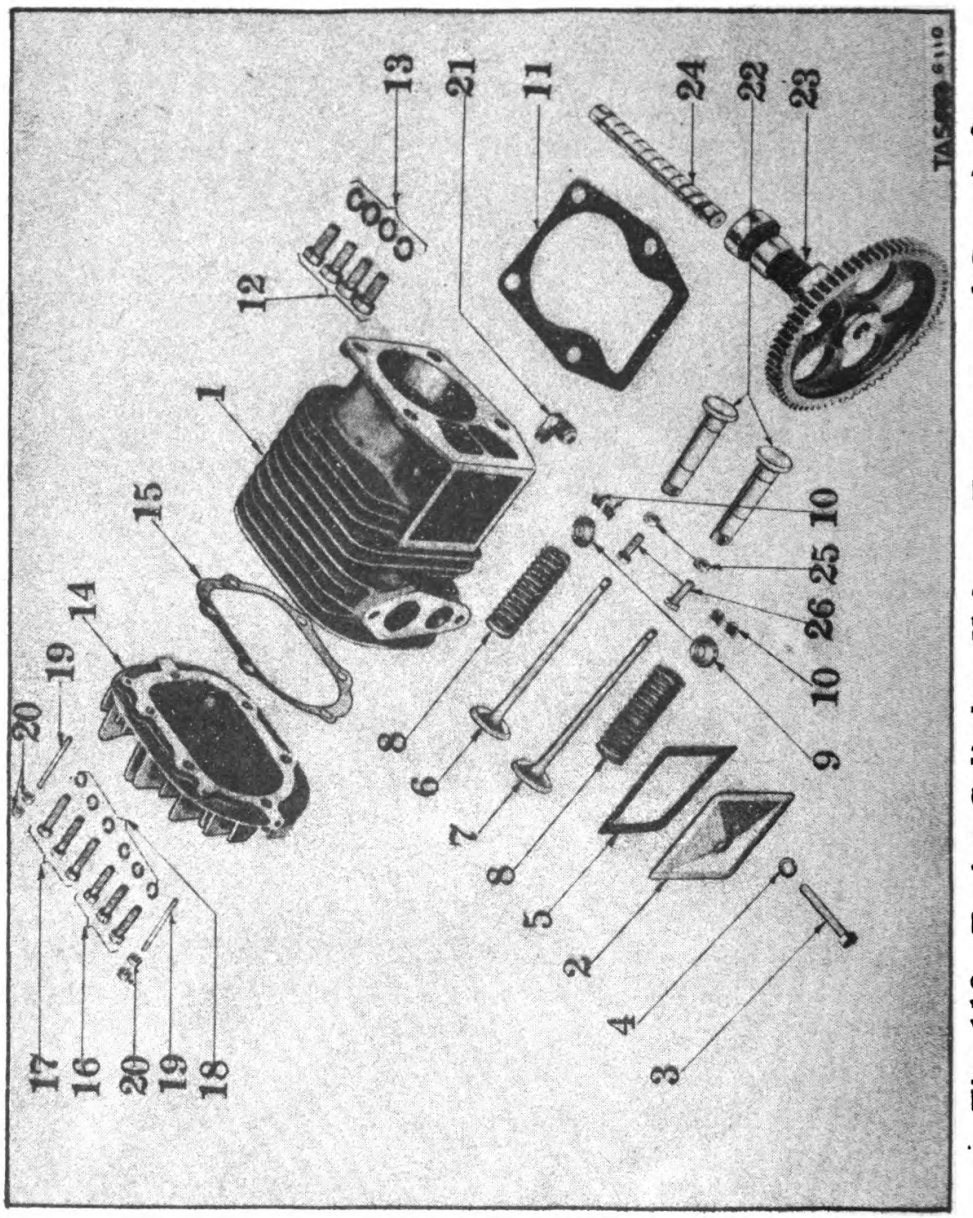

Fig. 110. Engine Cylinder, Valves, Tappers, and Camshaft.

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1. Cylinder.
2. Valve tapper inspection plate.
3. Cap screw.
4. Washer.
5. Gasket.
6. Exhaust valve.
7. Inlet valve.
8. Valve spring.
9. Valve spring seat.
10. Valve spring retainer lock.
11. Gasket.
12. Cap screw.
13. Washer.
14. Cylinder head.
15. Gasket.
16. Cap screws.
17. Cap screws.
18. Lock washer.
19. Air shroud cover stud.
20. Nut.
21. Breather line fitting.
22. Valve tappers.
23. Camshaft and gear.
24. Camshaft support pin.
25. Tapper adjusting screw nut.
26. Valve tapper adjusting screw.

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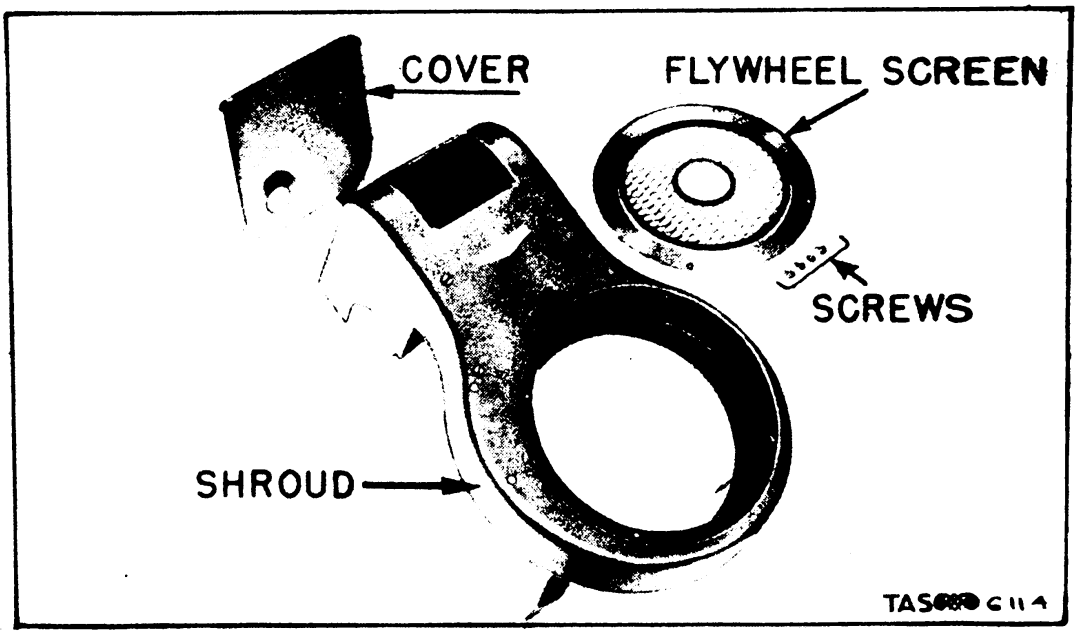

Fig. 111. Engine Air Shroud.

PROCEDURE	TOOLS
disengage manifold. (See fig. 114.)	
6. Remove adapter union holding breather line to engine and disengage line from engine. (See fig. 113.)	6. Open-end wrench.
7. Remove air cleaner bracket screw holding air cleaner assembly to engine and disconnect air cleaner assembly.	7. Screwdriver.
8. Remove four cylinder base	8. Open-end wrench.

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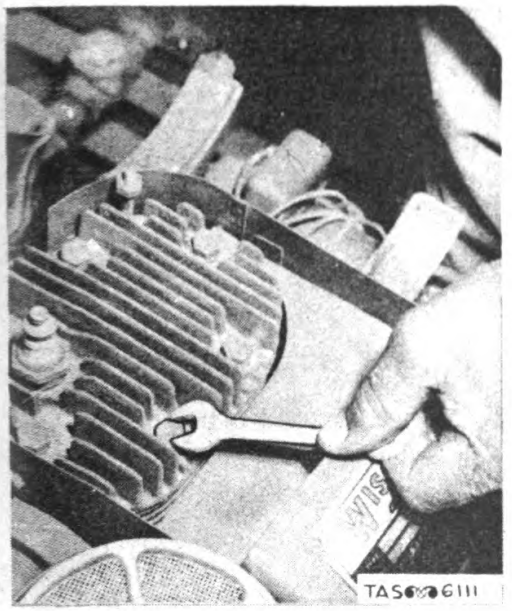

Fig. 112. Removing Cylinder Head Cap Screws.

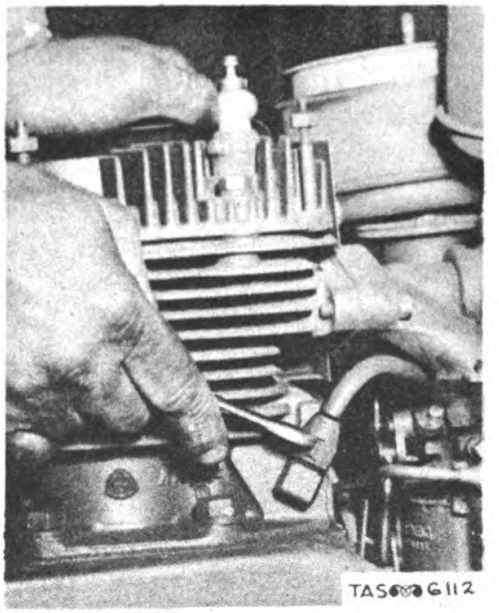

Fig. 113. Removing Adapter Union Holding Breather Line to Engine and Disengaging Line from Engine.

PROCEDURE	TOOLS
cap screws to either side of cylinder and remove cylinder from engine. The piston and connecting rod are now exposed. (See figs. 110 and 115.)	
(2) To assemble.	
1. Replace cylinder. Replace cylinder head.	1. Hand and open-end wrenches.
2. Replace air shroud cover.	2. Screwdriver.

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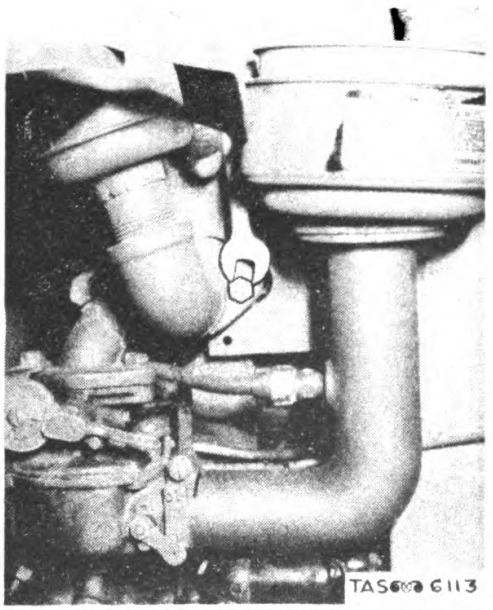

Fig. 114. Removing Carburetor Mounting Cap Screws Holding Manifold.

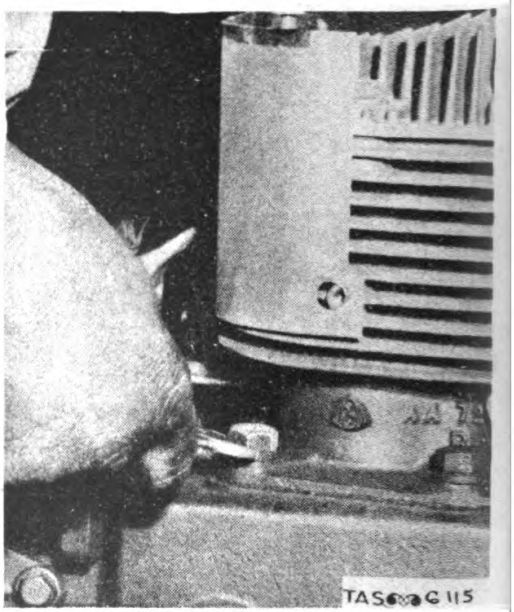

Fig. 115. Removing Four Cylinder Base Cap Screws and Removing Cylinder from Engine.

PROCEDURE	TOOLS
3. Replace engine control panel.	3. Open-end wrench.
4. Reconnect air cleaner assembly, breather line, and intake manifold.	4. Open-end wrenches and screwdriver.
5. Connect cable to spark plug.	5. Hand.

c. Engine generator on magneto-ignition model. (See fig. 116.) To remove.

1. Remove three bolts hold-	1. Open-end wrench.

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15. Frame
16. Circuit breaker lead
17. Spacer
18. Circuit breaker
19. Screw
20. Washer
21. Cover
22. Field connection insulation
23. Head band
24. Screw
25. Nut
25 a. Screw
26. Washer
27. Nut
28. Field coil
29. Pole piece
30. Screw
31. Armature
32. End plate
33. Screw
34. Washer
35. Screw
36. Washer
37. Washer
38. Brush spring
39. Brush holder
40. Main brush
41. Ground connector
42. Screw
43. Washer
44. Terminal
45. Screw
46. Oiler
47. Washer retainer
48. Ball bearing
49. Felt washer
50. Gasket
51. End cap cover
52. Screw

Fig. 116. Engine Generator on Magneto-Ignition Model.

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PROCEDURE	TOOLS
ing generator to engine.	
2. Disengage all wires from generator.	2. Hand.
3. Disengage drive belt from pulley and remove generator.	3. Hand.

d. Starting motor. (See fig. 118.) (1) To remove from magneto-ignition model.

1. Remove engine generator as directed in paragraph 30 c.	1. Tools as needed.
2. Disengage ignition cables.	2. Pliers.
3. Remove bolts holding starting motor to engine bracket, and remove starting motor.	3. Open-end wrench.

(2) To disassemble. (See par. 30 f.)

e. Engine generator on transformer-ignition model. (See fig. 117.) (1) To remove.

1. Disengage cable at conduit box.	1. Pliers.
2. Remove bolts holding generator to generator bracket and remove generator, lifting drive pulley free of	2. Open-end wrench.

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PROCEDURE	TOOLS
its belt.	
(2) To disassemble.	
1. Remove stud nuts and bolts holding front and rear brackets together and remove brackets.	1. Open-end wrench.
2. Remove armature and brush rigging assemblies. For aid in determining parts, consult figure 117.	2. Hand.

(3) To remove terminal covers so as to remove brushes. Unscrew with screwdriver and remove.

f. Engine starting motor. (See fig. 118.) (1) To remove from transformer-ignition model generator.

1. Disconnect cable from starting motor to solenoid switch.	1. Hand.
2. Remove starter mounting cap screws holding head assembly of starting motor to engine. Starting motor can now be detached.	2. Open-end wrench.

(2) To disassemble (regardless of model of generator on which found). Beginning with the cotter pin on the head assembly end, remove parts in the order shown in figure 118 until the armature and coil and brush assemblies are exposed.

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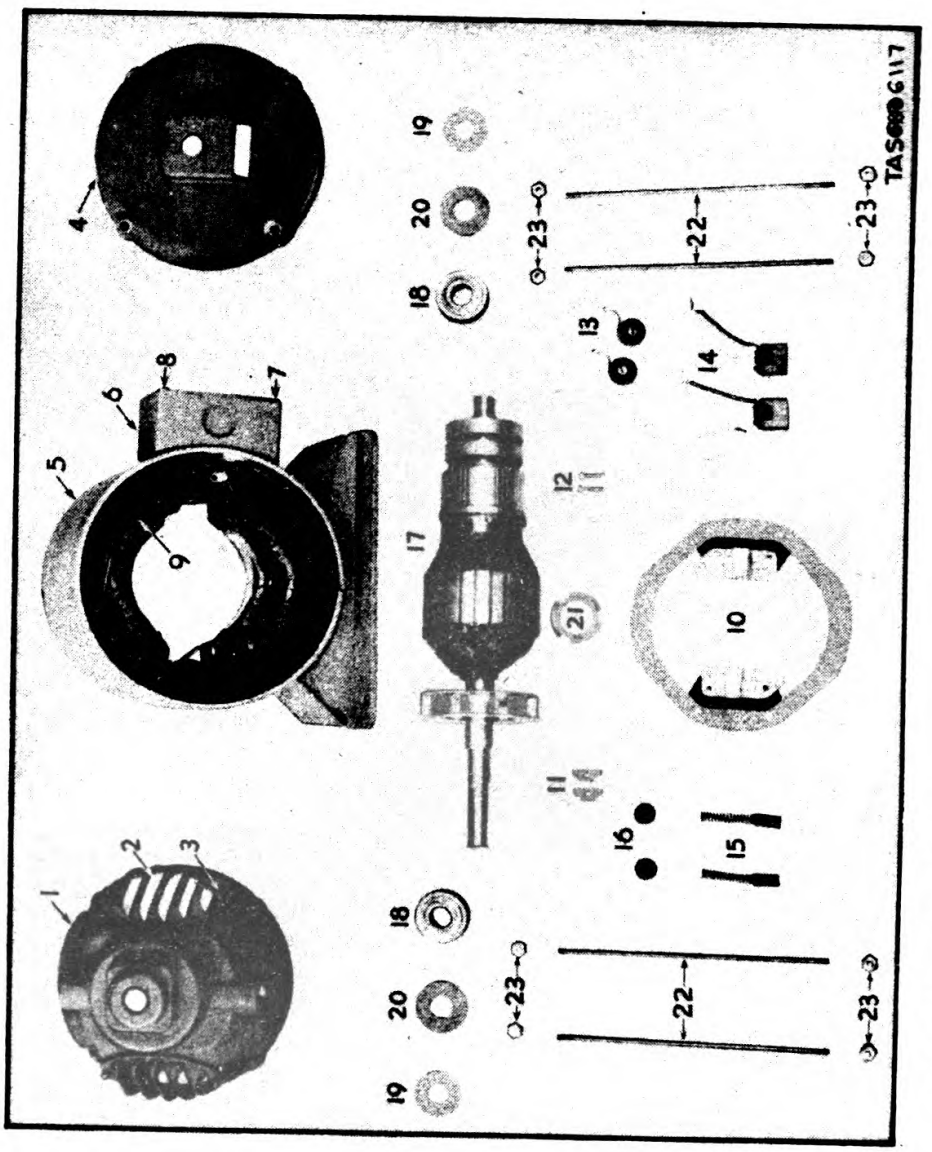

Fig. 117. Engine Generator on Transformer-ignition Model.

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1. Front bracket.
2. Terminal covers (open).
3. Screws.
4. Rear bracket.
5. Frame.
6. Conduit box.
7. Conduit box cover.
8. Screws.
9. Field coils.
10. Brush rigging assembly.
11. Brush rigging clamps.
12. Screws.
13. Brush tension springs.
14. Brushes (D.C.)
15. Brushes (A.C.)
16. Brush caps.
17. Armature assembly.
18. Ball bearings.
19. Felt washers.
20. Steel washers.
21. Loading spring.
22. Stud bolts.
23. Nuts.

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1. Cotter pin.
2. Nut.
3. Drive stop.
4. Anti-drift spring.
5. Sleeve.
6. Pinion.
7. Pinion.
8. Washer.
9. Meshing spring.
10. Drive spring support.
11. Drive spring.
12. Washer.
13. Drive end head.
14. Screw.
15. Washer.
16. Screw.
17. Washer.
18. Nut.
19. Armature.
20. Washer.
21. Felt pad.
22. Frame.
23. Screw.
24. Insulation.
25. Head band.
26. Nut.
27. Screw.
28. Field coil and brushes.
29. Pole piece.
30. Screw.
31. Brush spring.
32. Brush.
33. Grounded brush.
34. Grounded brush.
35. Brush.
36. Terminal post.
37. Insulating washer.
38. Insulating bushing.
39. Insulating washer.
40. Plain washer.
41. Lock washer.
42. Nut.
43. Washer.
44. Nut.
45. End plate assembly.

Fig. 118. Engine Starting Motor.

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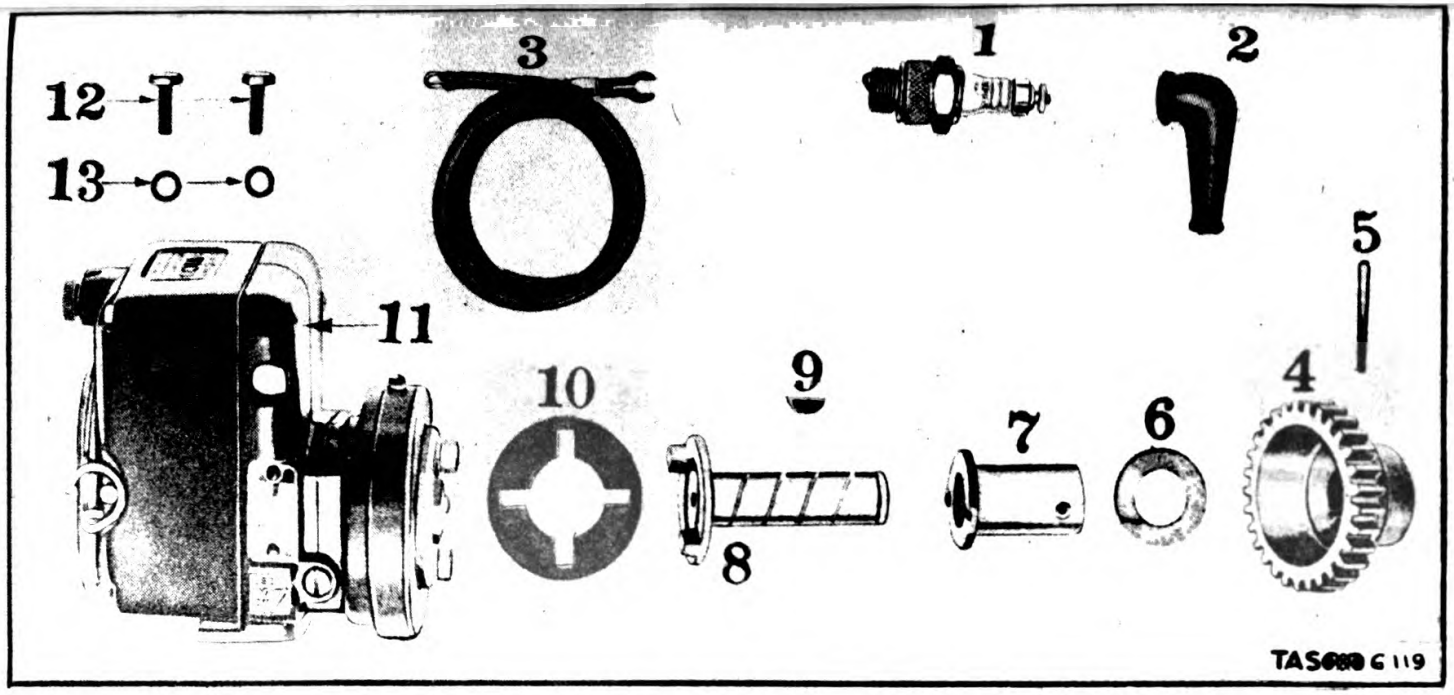

1. Spark plug.
2. Safety nipple.
3. Magneto cable.
4. Gear.
5. Pin.
6. Washer.
7. Bushing.
8. Drive shaft.
9. Woodruff key for magneto drive gear.
10. Coupling disk.
11. Magneto assembly with impulse coupling and cable.
12. Screw.
13. Washer.

Fig. 119. Engine Magneto.

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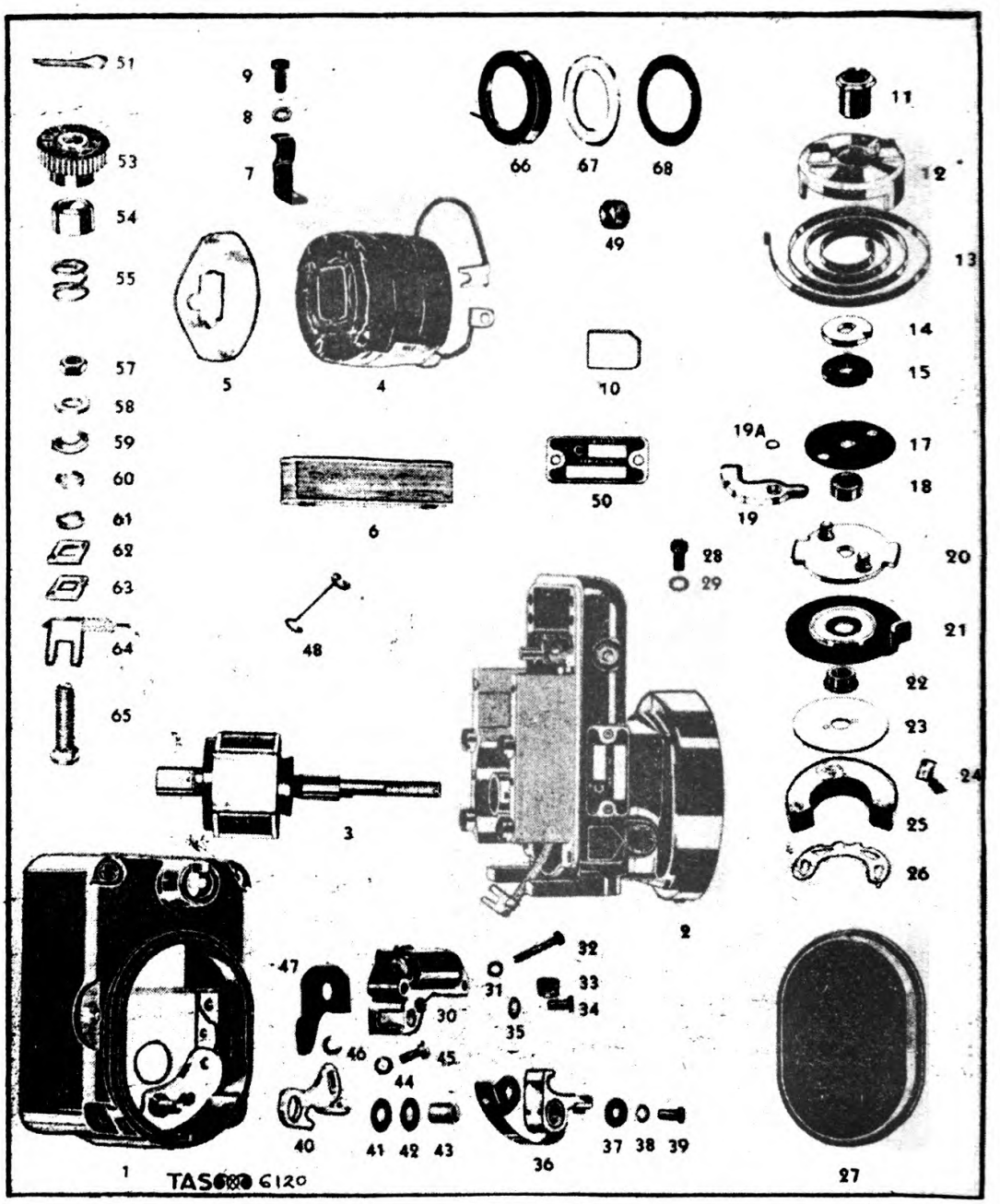

Fig. 120. Engine on Burner Magneto, Disassembled.

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1. Cover group.
2. Main housing group.
3. Rotor assembly.
4. Coil group.
5. Gasket.
6. Coil core group.
7. Clamp.
8. Washer.
9. Screw.
10. Wedge.
11. Bushing.
12. Drive cup.
13. Drive spring.
14. Washer.
15. Washer.
17. Spring retainer.
18. Spacer.
19. Trip arm.
19a. Snap ring.
20. Driven flange group.
21. Impulse stop group.
22. Impulse spacer.
23. Oiling disk.
24. Oil scraper spring.
25. Main oil pad.
26. Oil pad spring plate.
27. Breaker cover.
28. Impulse stop screw.
29. Washer.
30. Condenser group.
31. Washer.
32. Screw.
33. Packing.
34. Screw.
35. Washer.
36. Breaker arm group.
37. Washer.
38. Washer.
39. Screw.
40. Fixed compact.
41. Washer.
42. Washer.
43. Breaker arm spacer.
44. Washer.
45. Fixed contact screw.
46. Washer.
47. Gasket.
48. Breaker cover hold down spring.
49. Plug.
50. Identification plate.
51. Cotter pin.
53. Stop nut.
54. Grounding sleeve.
55. Grounding spring.
57. Nut.
58. Washer.
59. Washer.
60. and 61. Bushings.
62. and 63. Washers.
64. Ground stud lead
65. Ground stud.

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PROCEDURE	TOOLS

Necessary tools comprise pliers, screwdriver, and open-end wrenches.

g. Engine magneto. (See figs. 119 and 120.) To remove from engine.

1. Disconnect ignition cables.	1. Pliers.
2. Remove magneto mounting cap screws holding unit to base of engine. (See fig. 121.)	2. Open-end wrench.
3. Pull magneto loose from magneto drive shaft and remove it from engine.	3. Hand.

h. Burner magneto. (See figs. 119 and 120.) To remove from generator. Disconnect ignition cables, remove mounting cap screws holding unit to equipment frame bracket, and pull magneto loose from its coupling.

i. Carburetor. (See fig. 123.) (1) To remove.

1. Remove air cleaner bracket from carburetor. Remove manifold from carburetor.	1. Screwdriver and open-end wrench.
2. Disengage fuel line from carburetor. (See fig. 122.)	2. Open-end wrench.
3. Remove carburetor.	3. Hand.

(2) To disassemble.

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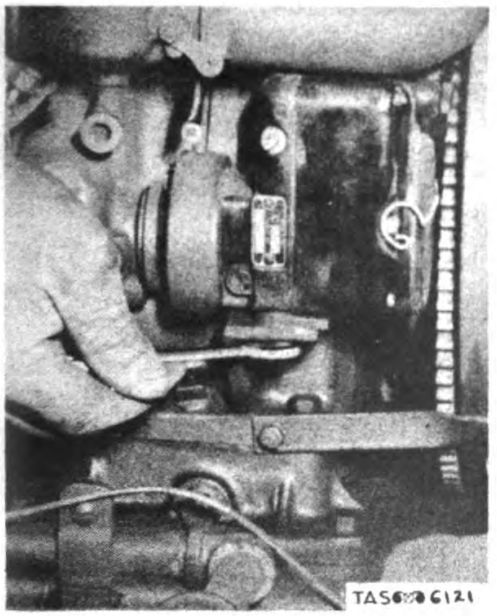

Fig. 121. Removing Magneto Mounting Cap Screws Holding Nut to Base of Engine Carburetor.

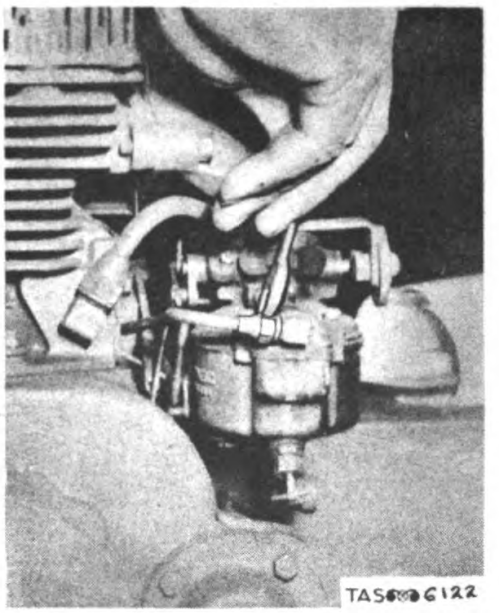

Fig. 122. Disengaging Fuel Line from Carburetor.

PROCEDURE	TOOLS
1. Remove throttle body from main body of carburetor by removing the four main body attaching screws holding these parts together.	1. Screwdriver.
2. Remove main jet plug (or main discharge adjustment needle as the case may be.)	2. Hand.
3. Remove main discharge jet (or main discharge adjustment body.)	3. Screwdriver.

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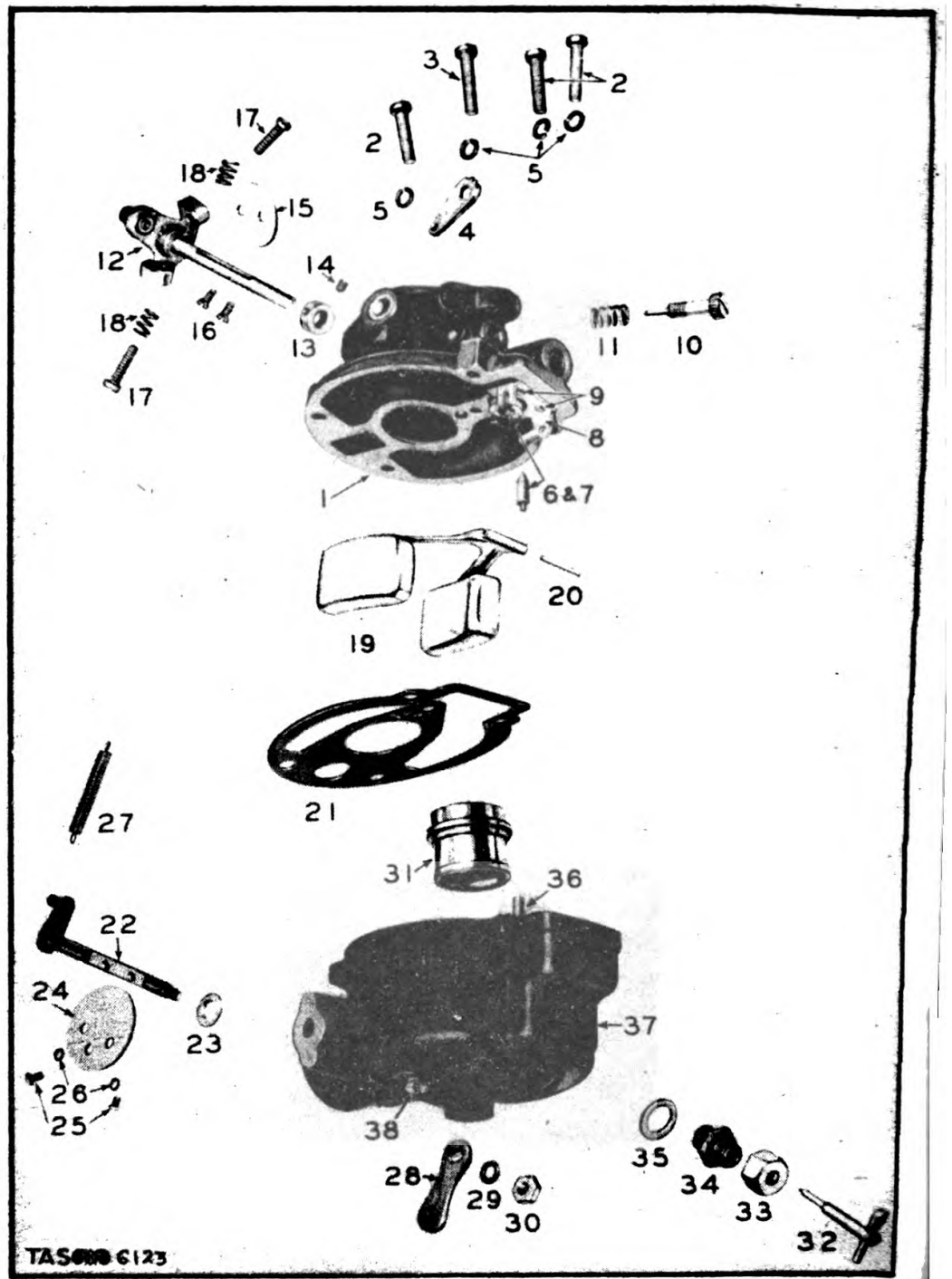

Fig. 123. Carburetor.

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1. Throttle body.
2. Screw.
3. Screw.
4. Clip.
5. Washer.
6. Float needle valve and seat.
7. Gasket.
8. Float hanger.
9. Screw.
10. Idle needle valve.
11. Idle needle valve spring.
12. Throttle stem and lever.
13. Collar.
14. Set screw.
15. Throttle valve.
16. Screw.
17. Stop screw.
18. Stop screw spring.
19. Float assembly.
20. Fulcrum pin.
21. Gasket.
22. Choke stem and lever.
23. Washer.
24. Choke valve.
25. Screw.
26. Washer.
27. Spring.
28. Choke lever.
29. Washer.
30. Nut.
31. Venturi.
32. Main discharge adjustment needle.
33. Nut.
34. Main discharge adjustment body.
35. Gasket.
36. Idle tube.
37. Main body.
38. Pipe plug.

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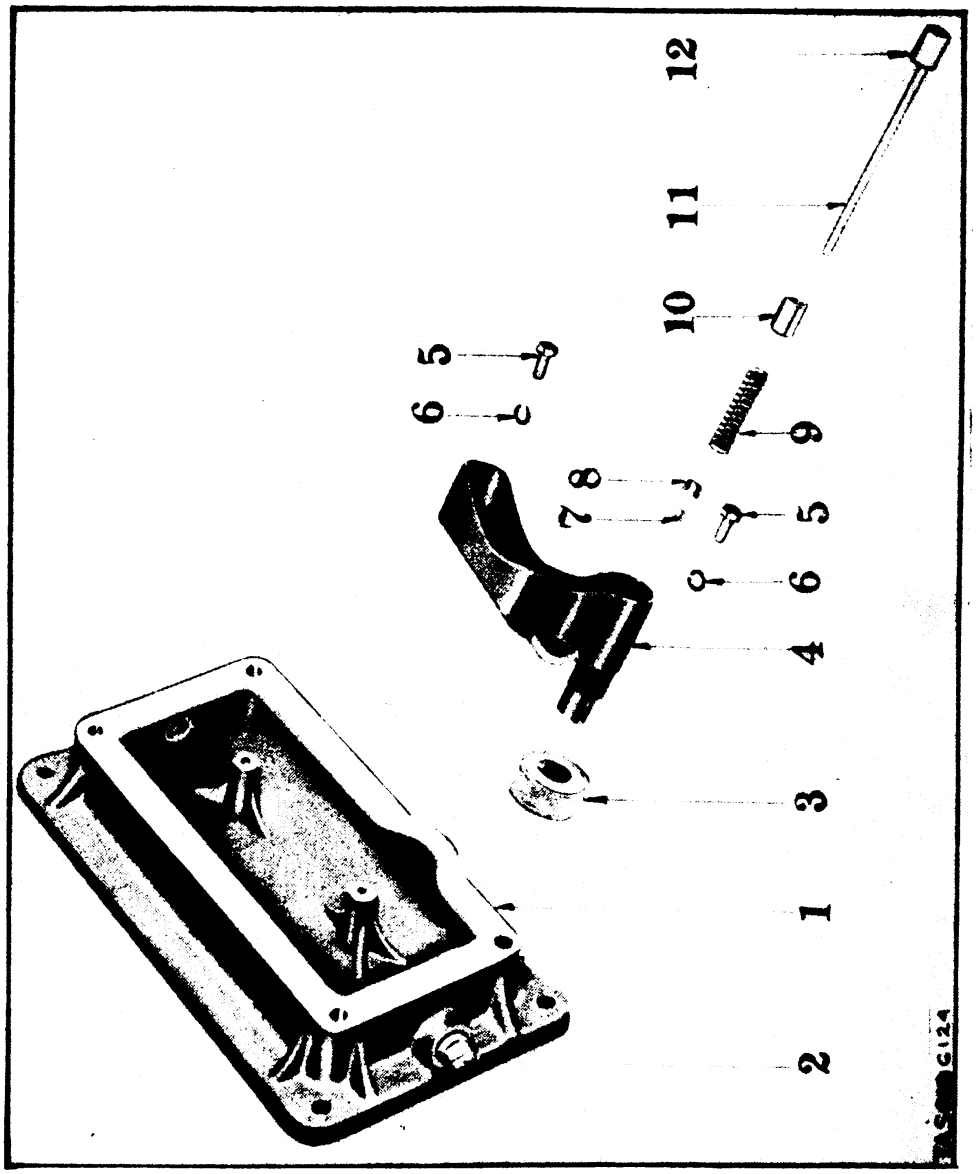

Fig. 124. Engine Base and Oil Pump.

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1. Base.
2. Plug.
3. Oil strainer.
4. Pump body for oil and splash trough.
5. Screw.
6. Washers.
7. Oil pump steel balls.
8. Oil pump ball retainer.
9. Spring.
10. Plunger.
11. Rod.
12. Cap.

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PROCEDURE	TOOLS
4. Remove metering jet.	4. Screwdriver.
5. Remove high speed bleeder.	5. Screwdriver.
6. Remove idle tube.	6. Pliers.
7. Remove idle needle valve.	7. Hand.
8. Remove small plug over idle needle valve, thus exposing idle discharge holes.	8. Screwdriver.
(3) To assemble.	
1. Replace parts in this order: main jet plug or adjustment needle; main discharge jet or adjustment body; metering jet; high speed bleeder; idle needle valve; idle tube; small plug over idle needle valve.	1. Tools as needed.

j. Engine base and oil pump. (See figs. 124 and 125.) To expose oil pump. Disengage all ignition cables from the engine, remove cap screws holding the engine base to the crankcase, and lift the upper part of the engine off the engine base.

31. ADJUSTMENTS AND REPAIRS. Those parts likely to need adjustment or repair are listed below in alphabetical order:

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a. Accumulator. (1) When functioning properly, the accumulator pressure builds up in about 3 minutes at the start of a run. This is checked by watching the water rise in the glass gage.

(2) If a leak develops in the glass nut near the top of the gage, air will leak out. This will be indicated by an ab-

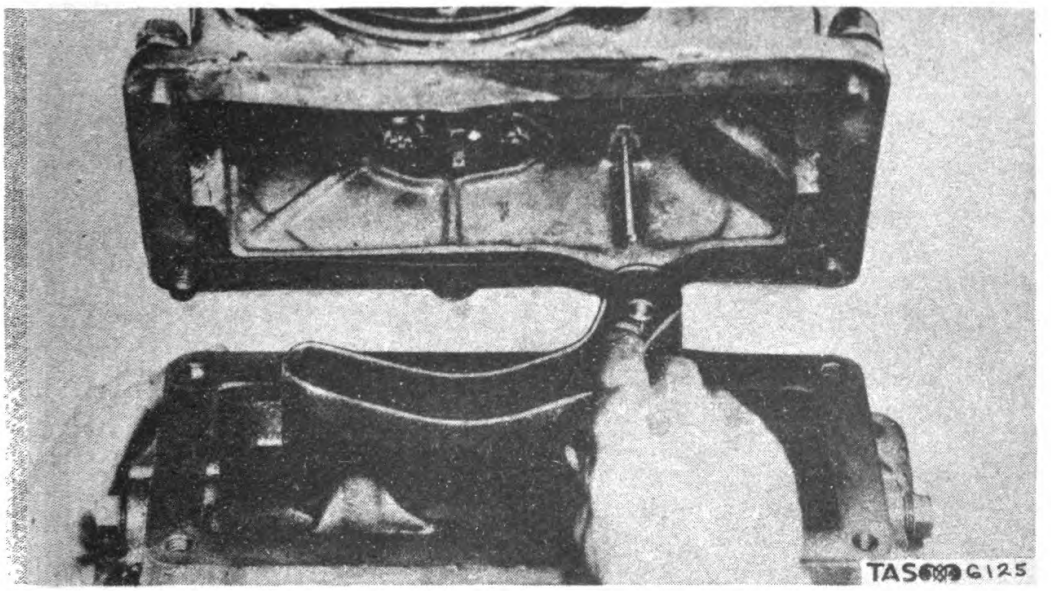

Fig. 125. Removing Cap Screws Holding Crankcase to Engine Base and Lifting Upper Part of Engine Off Base.

normal rise of the water in the glass gage. Correct by closing down the generator and tightening the glass nut; then drain the water from the accumulator by loosening the 1/2-inch union on the accumulator extension line at the bottom of the accumulator.

b. Alternating current generator for transformer-ignition model smoke generators. (1) Terminal covers should be

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removed and the commutator and brushes inspected at regular intervals. (See fig. 126.)

(2) Clean the commutator and brush with a strip of No. 00 sandpaper. (See fig. 127.) Do not use emery cloth. This operation can be performed with the armature revolving. All dust must be removed from the generator after the commutator has been cleaned.

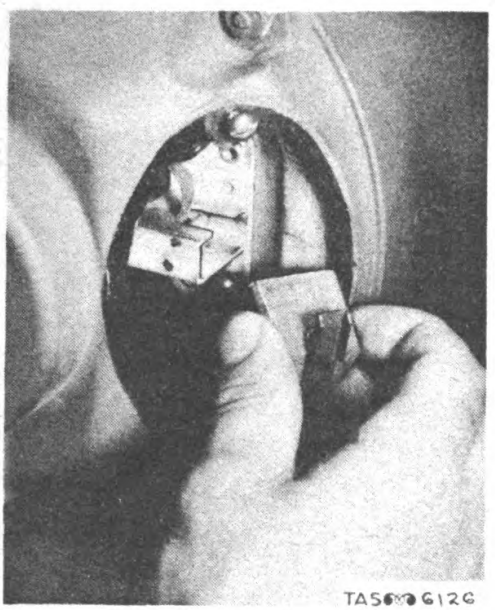

Fig. 126. Removing Terminal Covers and Commutator and Brushes for Inspection at Regular Intervals.

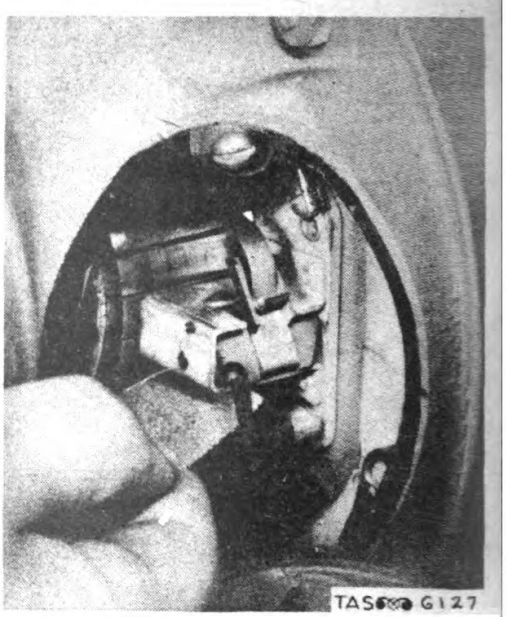

Fig. 127. Cleaning Commutator and Brush with a Strip of No. 00 Sandpaper.

(3) Inspect the brushes to insure that they are all free in the holders and that the tension springs are all in place and set firmly and uniformly against the brushes. The brushes are properly set at the factory and should not be shifted. Replace worn brushes.

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(4) Check the generator drive belt and tighten it if necessary. Replace worn or frayed belts.

c. Atomizing nozzles. (1) Remove nozzles as directed in paragraph 28 d.

(2) Clean the nozzle orifice and core slots with toothpicks or sharpened sticks. Do not use metal. Absolute cleanliness is necessary, as the least bit of dirt may clog the small apertures. After cleaning, hold the nozzle up to the air. If the hole can be seen through, it is clean. For heavy gum or carbon deposits, soak and scrub with a fibre bristle brush until the metal is bright and clean.

(3) When reassembling the nozzle pipe into the combustion head assembly (par. 28 d.) make sure that the pipe is pushed to its maximum forward position.

(4) The manner in which nozzles are handled before being installed and in subsequent servicing operations has an important bearing upon the quality of the flame in the firebox. The following rules should be observed:

(a) Never carry nozzles loose. They should be wrapped in paper and carried in their original box.

(b) Never put a nozzle into service without first taking it apart to insure that it is free of dust, lint, etc. It is recommended that each part be rinsed under a hot water faucet.

(c) Be sure that the grooved core is seated tightly, but do not force it.

(d) Nozzles which have been in service are best cleaned by soaking and washing them in a solvent. Very hot water also may be used. Never use metal to remove any particles or deposits from the nozzle. A sharpened match stick or

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toothpick is best. The grooves may be cleaned with hard-surfaced, non-fibrous paper such as writing paper. Never use a needle or wire to clean the orifice; use a toothpick.

(e) A series of clogged nozzles may be due to a ruptured fuel oil filter or strainer, or to dirt which has entered the nozzle during servicing. The fuel oil filter should be replaced if it is causing the trouble; otherwise the nozzles should be disassembled and thoroughly cleaned in lacquer thinner or very hot water.

d. Burner. (1) Before starting a burner that has been dismantled, see that the fuel oil shut-off valve is closed.

(2) With the gasoline engine running, the fuel oil pump should prime the fuel oil lines and filter in approximately 2 minutes. The fuel oil pressure as indicated on the pressure gage will be zero reading or fluctuating until the air is displaced. When a steady pressure of at least 100 pounds is maintained the burner is ready for operation.

(3) If the oil fails to ignite and there is a white vapor in the firebox of the furnace, close the shut-off valve and check the ignition system.

e. Control lever. (1) Throw the control lever into position firmly, but never try to force it beyond either of the two positions, "start-stop" and "run".

(2) During the "run" of the generator water sometimes fails to reach the coil assembly. This indicates that water orifice A is clogged. (See fig. 23.) This can be remedied without ceasing operations by disconnecting the quick-opening valve levers to which the control lever is attached at the rear of the generator control panel. The levers being disconnected, the water quick-opening valve on the water line above orifice B can be opened by moving the water quick-opening valve lever by

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hand. Water will now reach the coil assembly through orifice B. (See fig. 23.)

f. Dial thermometer. (1) It is important that the thermometer accurately indicates the temperature of smoke at the spray nozzles. Accuracy of the dial may be disturbed by jaring or excessive vibration. Check the thermometer by one of the following methods:

(a) Thermometer method. Compare the dial reading with the atmospheric temperature when the generator is cold and has not been operated for at least 5 hours. To obtain atmospheric temperature, use a reliable thermometer in the shade. If the dial reading checks with the atmospheric temperature, the dial thermometer can be considered accurate.

(b) Boiling water method. Remove the instrument bulb from the spray nozzle manifold (par. 29 a.), completely immerse the bulb in vigorously boiling water for at least 5 minutes, and then observe the dial reading. If the dial reads 212 degrees Fahrenheit (plug or minus 5 degrees), the dial can be considered accurate.

(2) If the dial reading does not agree with the atmospheric temperature (thermometer method) or fails to record 212 degrees Fahrenheit (boiling water method), correct it as follows:

(a) Carefully rotate the glass cover counterclockwise (i.e., toward the furnace) and lift it off.

(b) Hold the screw fastening the dial pointer to the shaft by means of a screwdriver. With the screw held immobile, move the pointer. If the thermometer test has been used, move the pointer so that it agrees with the atmospheric thermometer. If the boiling water test has been used, move the pointer to 212 degrees Fahrenheit.

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(3) After making one of the above adjustments, make sure that the dial pointer screw is tight, that the cover is carefully replaced (push it on and rotate it clockwise), and that if the boiling water test has been made the instrument bulb is firmly replaced.

g. Drive belts. The drive belts, particularly those connected to the special oil and water pumps, may become loose. To tighten, loosen the bolts holding the pump in place and move the pump away from the engine take-off shaft. V-belts should not be tightened so much that they twang or are resonant when plucked. Tightening these belts too much will cause them to wear out too quickly. Tighten them until there is only a very slight slack.

h. Electrode assemblies. (1) The position of the electrodes with respect to the atomizing nozzle is important, and the width of the gap between the electrodes is also very important.

(2) On units having magneto-ignition of the burner mixture the points should be set 1/4-inch apart, 1/2-inch above the center line of the nozzle orifices, and in a line drawn between the center line of the nozzles and the lip of the cast iron deflector as shown in figure 128.

(3) On units having transformer-ignition the points should be drawn back so that there is about 1/16-inch clearance between them and a straight edge located as in figure 128. The gap between electrodes should be 1/4-inch.

(4) Check the placement of the electrode points with the electrode gage to be found in the tool box on the frame of the generator. Place the large end of the gage so that each corner rests on the nozzle hole. Points should fit into the open "V" at the center of the gage. (See fig. 129.)

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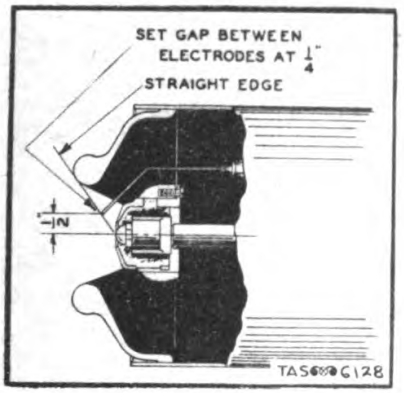

Fig. 128. Setting Electrode Points on Combustion Head Assembly.

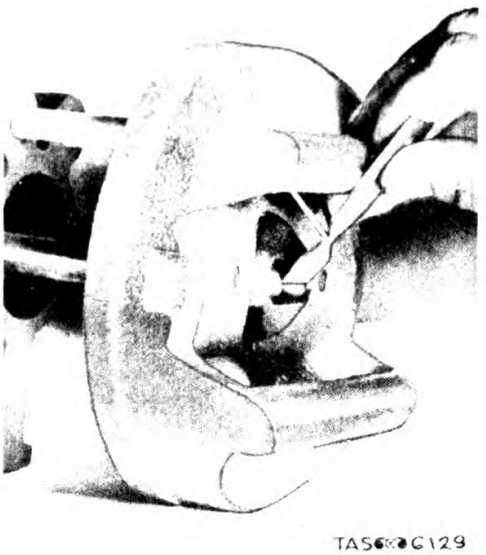

Fig. 129. Checking Electrode Points with Electrode Gage.

(5) The above instructions with respect to the electrodes must be followed to prevent creating an explosive condition, caused by spraying fuel oil into a hot firebox without spark ignition.

i. Engine - oil bath air cleaner assembly. (See fig. 108.) (1) An air cleaner is used on the carburetor intake of the engine to prevent dust being drawn into the engine through the carburetor - a condition which would cause the cylinder, piston, rings, and other engine parts to wear out in a few weeks' time.

(2) The filter of the oil bath which serves as an air cleaner on the generator engine must be cleaned periodically, depending upon operating conditions. (See fig. 130.) The oil in the body, together with the collected dust, should be emptied

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and the body then refilled with oil to the level indicated on the body. Under extremely dusty operating conditions it may be necessary to service the air cleaner once or twice a day.

j. Engine - carburetor. (See fig. 123.) (1) To adjust for idle or low speed. Have the engine well warmed up so that the manifold is at least warm to the hand. Close the throttle

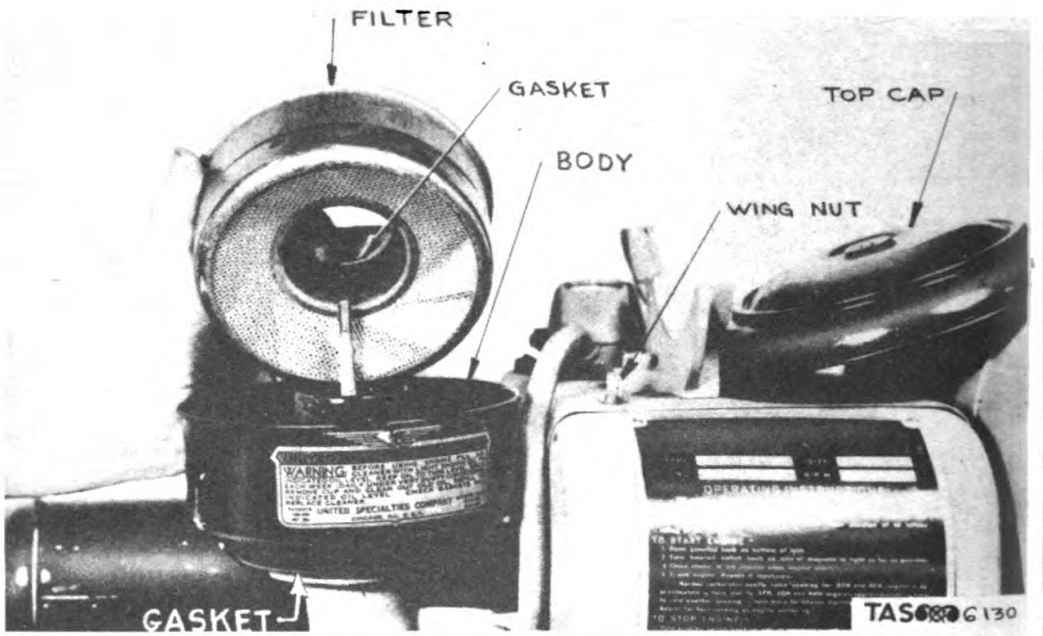

Fig. 130. Filter on Oil Bath Must Be Cleaned Periodically.

until the minimum steady idling speed is reached. Turn the idle needle valve gradually to right or left until the engine runs as steadily and as fast as this throttle position will permit. The idle needle valve operates on air. Therefore, screwing it IN gives a richer mixture - OUT a leaner one. If after adjustment the engine idles too fast or too slowly, the desired speed can be obtained by turning the throttle stop screw. If satisfactory adjustment cannot be obtained, see that idle discharge holes are

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open and free to allow a free flow of gas.

(2) To adjust for intermediate and high speed. The mixture for intermediate and high speeds is controlled by either an adjustment metering jet or by a fixed metering jet. Smoke generator engines are equipped in most cases with an adjustment jet, the adjustment needle for which is screwed into the carburetor body at the bottom in place of the main jet plug. For adjusting mixture when adjustable jet is used, follow this procedure: Set the throttle about one-third open, turn the main discharge adjustment needle in until the speed of the engine is noticeably cut down, then turn the needle out slowly until the fastest and steadiest speed for that throttle position is obtained.

(3) The gasoline level in the float assembly of the carburetor is set properly at the factory, and should not be adjusted unless the carburetor has been handled roughly or its level has changed from some other cause. The level is set at 15/32-inch to 17/32-inch below the top of the main (or lower) body. If it is necessary to reset this level, it can be done by holding the throttle (or upper) body in an inverted position and setting the floats to measure 1-1/4-inch from the top of each float to the gasket surface of the throttle body. This will give the approximate fuel level.

(4) The float needle valve must seat tightly and must be free from specks of dirt and from wear. A poorly seating float valve will cause leakage and too high a fuel level will result. A high fuel level will cause too rich a mixture and flooding of the carburetor. This condition will also cause hard starting, especially if the engine is warm from previous running. To clean or replace the float needle valve and seat, the float fulcrum pin should be withdrawn, allowing the float to be removed. This will expose the float needle valve and seat.

k. Engine - governor. (See fig. 47.) The governor spring is adjustable for various engine speeds. The greater the

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tension on the spring the higher is the engine speed. Three holes are provided in the governor control lever for the spring. For engine speeds up to 1,800 revolutions per minute the spring should be hooked into the inner hole of the lever. The best operating speed for the engine is 1,800 revolutions per minute without load.

1. Engine - cylinder. (See fig. 110.) It is occasionally

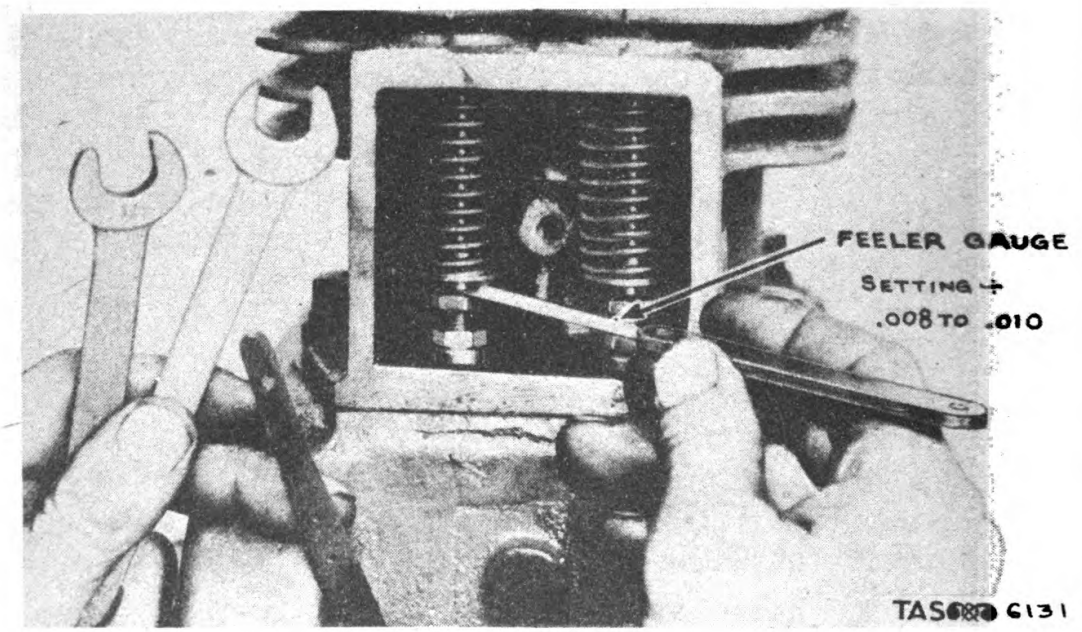

Fig. 131. Inserting Feeler Gage to Determine Tapper Clearance.

necessary to adjust the tappers (tappets) on the exhaust and inlet valves in the cylinder. The proper tapper clearance is .008-inch to .010-inch. What the clearance is may be determined by inserting a feeler gage of the proper thickness (approximately .010-inch) between the valve tapper adjusting screw and the valve spring. (See fig. 131.) To adjust the tapper, use two open-end wrenches. Hold the lock nut with one wrench and turn the valve tapper adjusting screw with the other until the proper

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clearance is obtained. (See fig. 132.)

m. Engine - magneto. (See figs. 119 and 120.) (1) When installing the engine magneto care should be taken to insure that there is a proper alinement. Before tightening the magneto mounting cap screws firmly this alinement should be checked by turning over the motor, at the same time ascertaining that the magneto drive shaft has sufficient play endwise during each turn of the cycle. Care should also be taken to insure that the screws are short enough so that they are clamping the magneto down and not just bottoming in the tapped holes of the magneto.

(2) The breaker point opening on the magneto should be adjusted to .015-inch by means of the screw head eccentric acting on the fixed contact. (See fig. 133.) Clearance can be tested by means of a .015-inch feeler gage.

(3) If the impulse coupling becomes clogged with dirt the necessity for flushing it is evidenced by the trip arms failing to engage or disengage, or by sluggishness in the action of the impulse when it trips. The impulse should be flushed out thoroughly with kerosene, care being taken, however, not to allow any of the kerosene to work its way into the housing.

(4) It is recommended that if breaker points need replacing, both the fixed contact and the moving points be replaced at once.

n. Fixed needle valve. (1) An excessive rise of the dial thermometer, that is, a rise to above 925 degrees Fahrenheit, can sometimes be corrected by opening the fixed needle valve beyond its normal point. To do this, remove the top and turn the stem with a key which will be found in the tool box on the generator frame. Opening this valve permits more special oil to enter the coil assembly, thus cutting down the temperature.

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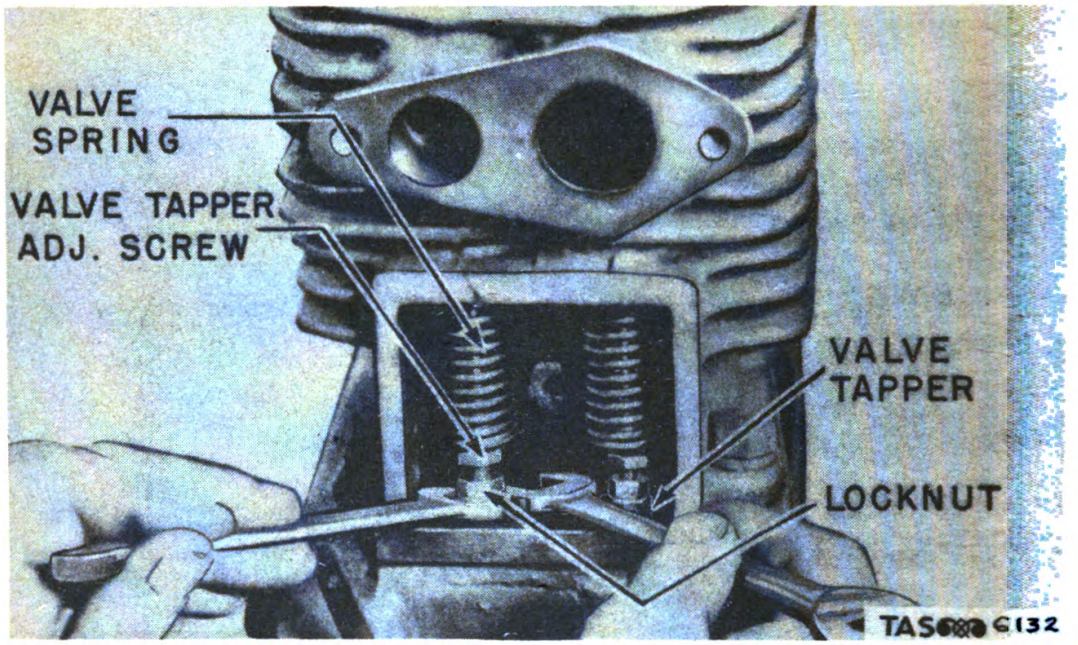

Fig. 132. Adjusting Tapper Clearance.

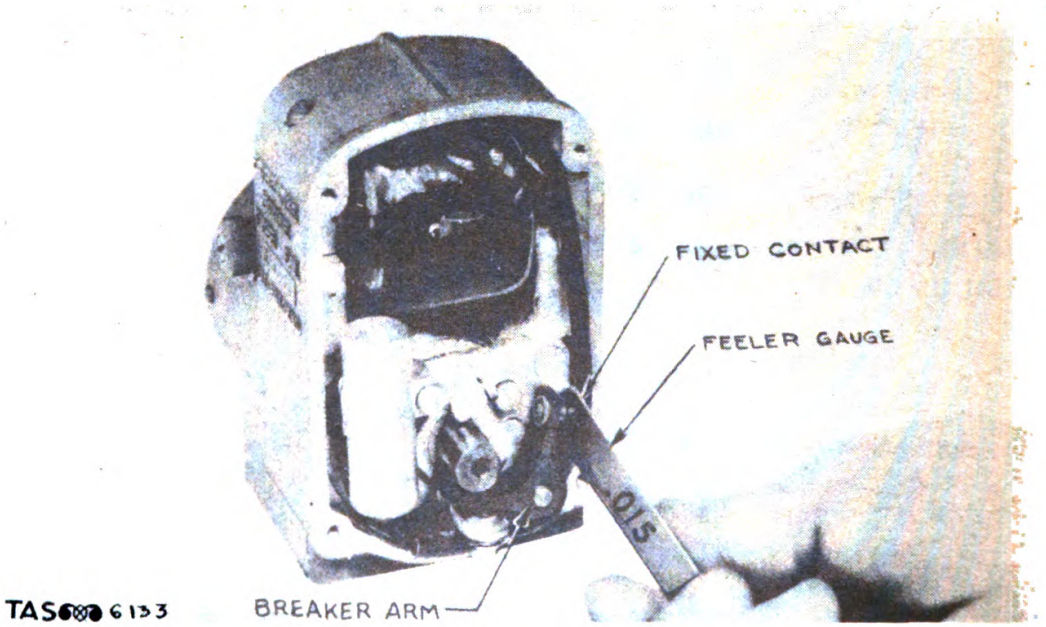

Fig. 133. Adjusting Magneto Point.

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(2) After extensive use this valve may require cleaning. To do this, remove the top. Removing the top will not affect the setting of the valve.

(3) In hot weather the valve may have to be adjusted to allow for the thinning of the special oil. In cold weather it may have to be adjusted to allow for thickening. Turn it toward the CLOSED position in hot weather, toward the OPEN in cold.

o. Fuel oil suction line filter. (See fig. 30.) To clean the filter.

(1) Close the fuel oil gate valve.

(2) Remove the filter assembly from the system.

(3) Disassemble the filter assembly in the same manner that the water filter is disassembled. (See par. 27 a.)

(4) Wash out the shell with clean fuel oil, kerosene, or other cleaning solvent.

(5) Remove the filter tube with its core and wash it thoroughly in fuel oil, kerosene, or a cleaning solvent of similar approved class. DO NOT USE GASOLINE OR ANY OTHER HIGHLY VOLATILE AND FLAMMABLE LIQUID. Rinse the tube and core repeatedly but do not scrape it or use any brush or scraper to remove sediment. Scrubbing or scraping tends to disturb the windings and the fibre arrangement and may destroy the value of the filter.

(6) Examine the tube and core after washing. If the fibres have been damaged or there are heavy deposits of gum or sediment which are not readily removed by soaking, the tube and core should be replaced.

(7) Replace the tube and core in the shell, forcing

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it over the sealing at the bottom.

(8) Fill the shell nearly full of clean oil to reduce the amount of venting when starting up the burner.

(9) Using a new gasket, reinstall the shell and the filter tube and core, making sure that the top opening of the tube and core engages the sealing plug in the filter head.

(10) Reassemble the filter assembly and attach it to the system.

(11) Open the fuel oil gate valve and start the burner, venting air from the oil system if necessary to establish suction in the system.

p. Generator and circuit breaker on magneto-ignition models. (See fig. 118.) (1) Normal service may be obtained from the generator if a regular inspection and maintenance procedure is adhered to.

(2) The head band assembly should be removed and the commutator and brushes inspected at regular intervals.

(3) Inspect the commutator and, if dirty, clean it with a strip of No. 00 sandpaper. Do not use emery cloth. All dust must be cleaned from the generator after the commutator has been cleaned.

(4) Excessive brush spring tension will cause the commutator and brushes to wear rapidly. Low spring tension will cause a reduced generator output, arcing and burning of the commutator and brushes.

(5) Replace worn brushes. Do not use emery cloth or sandpaper to seat the brushes. This should be done by means of a "bedding stone."

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(6) Check the generator drive belt and tighten it if necessary. Replace the belt if it is frayed or worn.

(7) A noisy generator may be caused by loose mounting or drive pulley; worn, dry, or dirty bearings.

(8) To adjust the air gap on the circuit breaker disconnect the circuit breaker from the battery. Circuit breaker points must not be closed by hand with the battery connected. This would allow a heavy current to flow into the generator and seriously damage it.

(9) If circuit breaker points require cleaning, do not use emery cloth or sandpaper as particles of emery or sand might remain embedded in points' surface and prevent normal operation. Use spoon or riffler file.

q. Orifices. (1) At all times the water orifices on the water manifold must be kept clean, as any obstruction is likely to reduce or prevent the flow of water to the coil assembly, a condition which will damage the machine.

(2) Remove and inspect the orifices periodically. Clean with pointed stick of soft wood, such as a toothpick. Never use metal for this purpose.

r. Pressure regulating valve. To adjust, remove the cap. Turn the stem with a screwdriver. Turn in a clockwise direction (i.e., toward the fuel oil pressure gage) to increase the oil pressure. Turn counter-clockwise to decrease it. Increasing the oil pressure to 130 pounds per square inch will raise the oil burning rate nearly 1/2-gallon per hour. Lowering the pressure will reduce the oil rate correspondingly.

s. Quick-opening valves. (1) These valves can give trouble by failing to close tightly. If the special oil quick-opening valve does not seat tightly the generator will discharge an

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excessive amount of smoke or oil through the spray nozzles during the "start-stop" period of operations, and this may lead to spraying the generator and the operator with liquid oil. (Note: A small amount of bluish smoke is often discharged during the "start-stop" period. This is not at all abnormal. If the water quick-opening valve does not seat tightly the coil assembly will be provided with more water during the run than is desirable.)

(2) When the water quick-opening valve is shut tight the special oil quick-opening valve should be only about 3/4 of the way open. In no case should it be more than 7/8 open. This assures that with the control lever in the "run" position the water quick-opening valve will always be tightly shut.

(3) Both valves should be regularly inspected and cleaned to prevent clogging.

t. Relief valves. (1) It is extremely important that these valves be kept spotlessly clean.

(2) Sometimes a relief valve can be cleared by simply tapping its bonnet with a heavy tool, such as the head of a large screwdriver. If this fails to dislodge dirt, clean the strainer nearest the valve, remove the valve bonnet, and wipe out the interior with a clean, lintless rag.

(3) Each relief valve on the generator is set to permit the passage of a predetermined amount of fuel. To increase or decrease the relief, loosen or tighten the spring. This can be done by removing the top, holding the nut with one open-end wrench, and turning the screw with another. (See fig. 134.)

u. Spark plug. (See fig. 135.) The correct gap on the spark plug is .025 inches.

v. Special oil hand-regulating needle valve. (1) This valve must be closed tightly before starting operations. As soon

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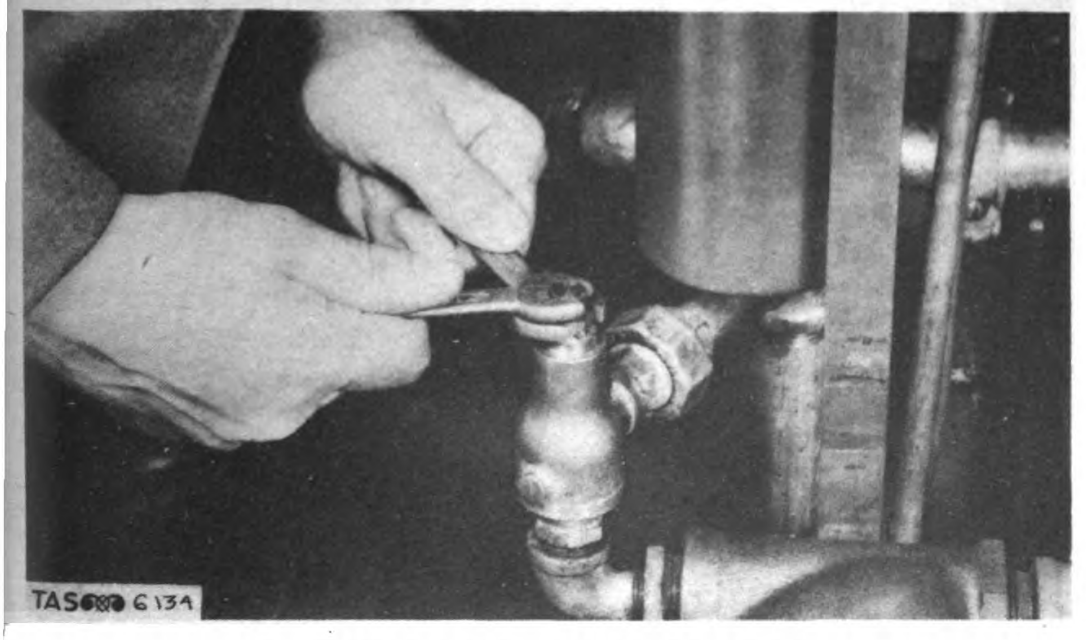

Fig. 134. Adjusting Relief Valve.

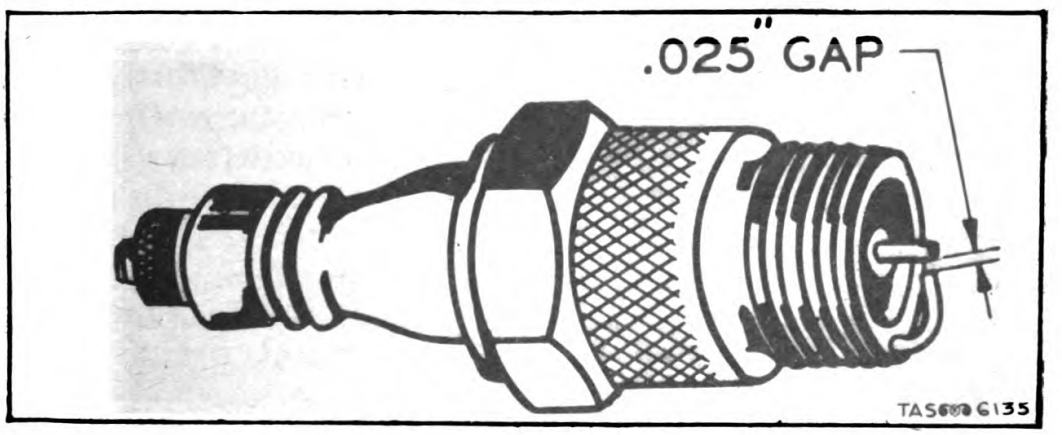

Fig. 135. Correct Gap on Spark Plug Is .025 Inch.

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as the control lever is moved to the "run" position and the temperature reaches 820 degrees Fahrenheit, open this valve one-half turn. As previously explained, the hand-regulating valve is used to control the temperature range on the dial thermometer. This range should read between 875 and 925 degrees Fahrenheit when the unit is in full operation.

(2) The temperature range is maintained by opening and closing this valve. Opening the valve increases the flow of special oil into the coil assembly. This lowers the temperature. Closing the valve decreases the flow, raising the temperature. Do not expect the dial thermometer to respond immediately and do not turn the valve more than one-quarter turn either way at a time.

w. Strainers. (1) Self-cleaning strainers can be cleaned with the generator in operation. Simply turn the handle, and at intervals remove the drain plug at the bottom to allow dirt to escape. From time to time the strainer should be disassembled and all parts washed with a solvent.

(2) Screen-type strainers are cleaned by removing the cap and screen and washing the screen and the body at frequent intervals. When these strainers are disassembled air sometimes collects inside. To remove air from the self-cleaning strainer, loosen the bleeder plug with a screwdriver. (See fig. 136.)

(3) The filter element of the water filter and the tube and core of the fuel oil filter should be renewed when either becomes darkened, stained, or clogged.

x. Spray nozzles. These nozzles must always be tightly screwed into their proper locations and must be entirely clean. If one becomes obstructed the result will be an irregularly shaped jet of smoke spraying at an irregular angle. The nozzles may be individually unscrewed and cleaned. The spray nozzle

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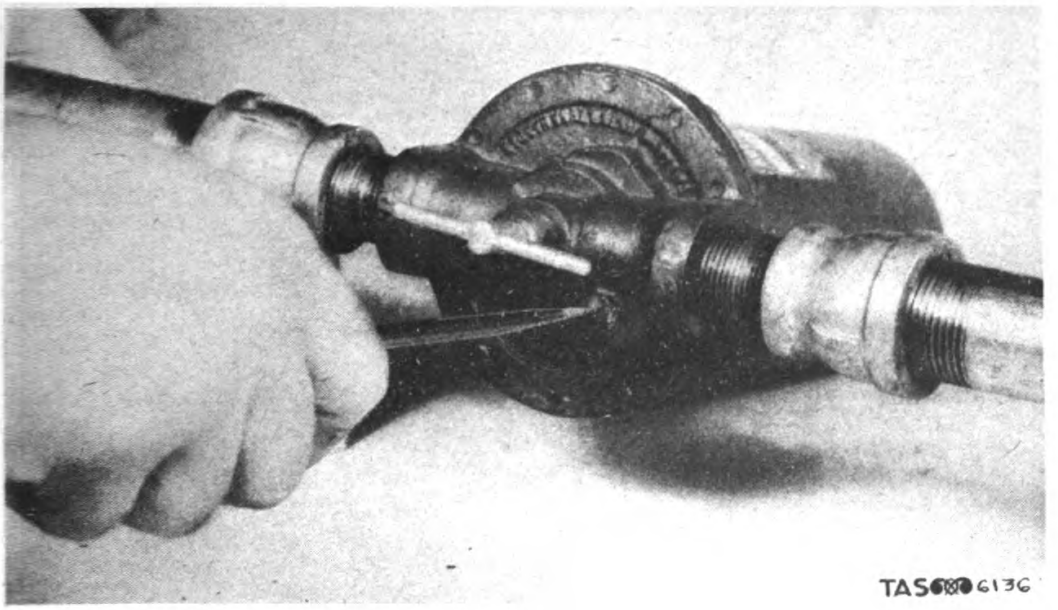

Fig. 136. Loosening Bleeder Plug to Release Air from Self-cleaning Strainer.

manifold is equipped with caps at each end. These may be unscrewed and cleaned.

y. Water pump. (See figs. 137 and 138.) In case of leakage, insert added felt glands in the packing box housing or replace worn ones. To do this, remove the pump from the system, disassemble the packing gland assembly, and add or replace glands as needed.

32. TROUBLE SHOOTING AND SERVICE TESTS. a. Trouble shooting. (1) Very often when the mechanical smoke generator produces bad smoke or develops some other trouble the cause can be traced by checking the various indicators. There are six indicators: the dial thermometer and the five pressure gages. (On some modified generators, there are only four pressure gages.) If any one or any combination of these indicators is not showing the reading it should it is a fairly definite sign

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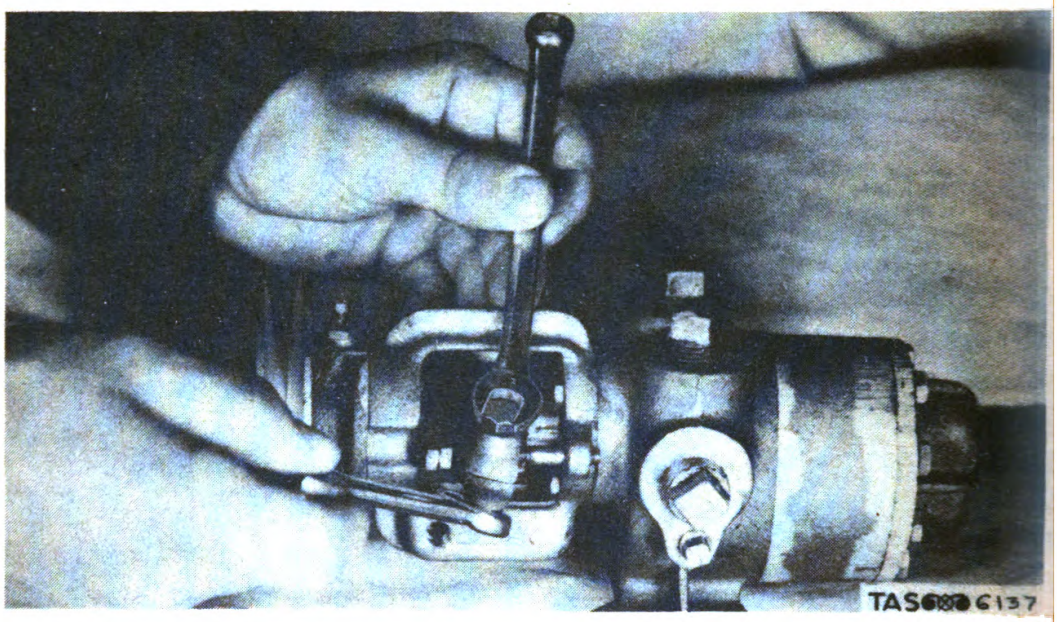

Fig. 137. Disassembling Packing Gland Assembly of Water Pump.

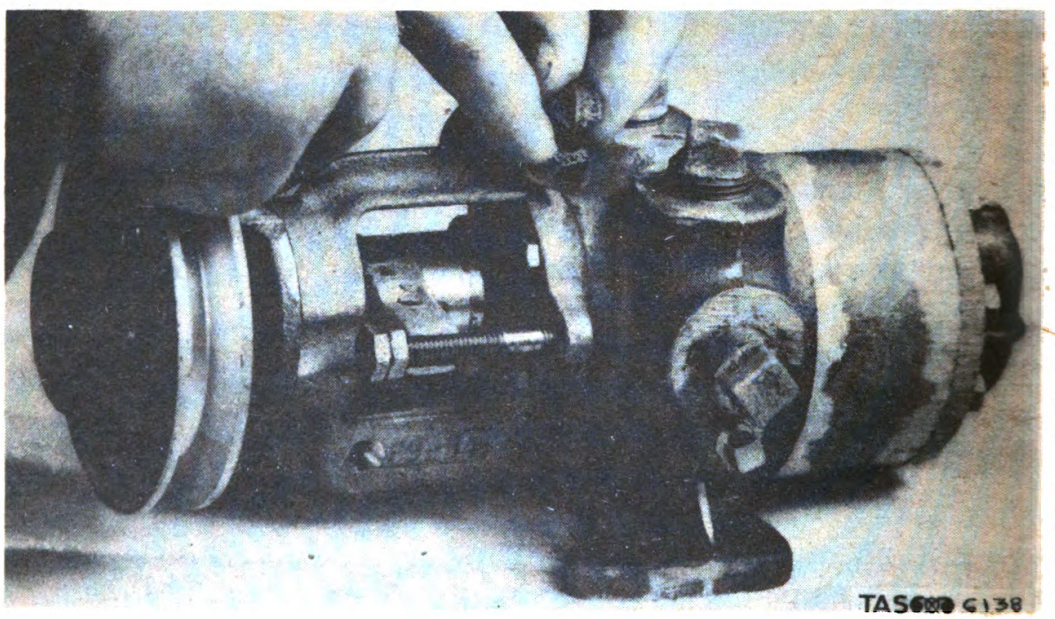

Fig. 138. Inserting New Gland in Water Pump.

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that the difficulty lies in the system or systems to which the indicator or combination of indicators is attached. If, for example, the fuel oil pressure gage is reading wrongly, the chances are the trouble is being caused by the fact that too much or too little fuel oil is entering the burner.

(2) As has been previously pointed out, the dial thermometer is an absolute indicator. During the run of the generator in the "run" position the thermometer reading must be kept between 875 and 925 degrees Fahrenheit, and any deviation from this reading must be corrected even though the generator is producing good smoke and is functioning properly in all other respects. THIS IS AN ABSOLUTE RULE! It will be remembered, of course, that the control lever is thrown into the "run" position when the thermometer reading reaches only 700 degrees Fahrenheit (500 degrees in extreme cold). It then requires a little time before the 875 degree point is reached. Once the 875-925 degree range is reached, however, it must be maintained throughout the run.

(3) The gage readings are not absolute. Do not tamper with the generator simply because one of the gages is reading wrongly. If the generator is producing good smoke and all parts of the generator are running smoothly, the fact that one of the gages is off, i.e., indicating abnormal pressure, etc., probably means nothing at all. The gages are simply signposts which help the operator to find the trouble after it has developed. The rule is: If trouble develops, check the gages.

(4) So that he may know when his indicators are reading properly, it is suggested that the operator paste the "start-stop" pressure gage chart shown in figure 139 on his generator. It shows what the special oil, fuel oil, and water pressure gages should read right after flame appears in the firebox while the generator is being warmed up in the "start-stop" position.

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Fig. 139. "Start-Stop" Pressure Gage Chart.

Fuel Oil	110 - 140 lbs.
Special Oil	about 60 lbs.
Water	gradually rising.

(5) It is suggested also that the operator paste the "run" chart in figure 140 on his generator. It shows the proper readings for all pressure gages while the generator is running in the "run" position.

b. Service tests. There are no hard and fast rules on what to do when the mechanical smoke generator produces bad smoke or develops some other trouble. The operator must learn the "eccentricities" of his machine and the most likely causes of them through experience. As a guide to locating the cause or causes of trouble, the following tests are suggested:

c. Fuel oil pressure test. (1) Purposes. (a) To determine fuel oil pressure at atomizing nozzles.

(b) To indicate the presence of obstructions in the fuel oil relief valve or in the fuel oil return line.

(c) To indicate obstructions or air leaks in the fuel oil suction line or in the fuel oil filter.

Fig. 140. "Run" Pressure Gage Chart.

Special Oil	50 - 55 lbs.
Water	55 - 60 lbs.
Spray nozzle	10 - 20 lbs.
Coil	30 - 45 lbs.
Fuel Oil	110 - 140 lbs.

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(2) Method. (a) Test-run the generator.

(b) Watch the fuel oil pressure gage.

(3) Signs. (a) Obstructions in the fuel oil suction line will cause the fuel oil pressure gage to register a partial pressure and then drop gradually as the vacuum in the suction line increases due to the pumping of air.

(b) Large air leaks are indicated by slow, wide fluctuations of pressure finally resulting in loss of prime.

(c) Small air leaks are indicated by small instantaneous fluctuations, usually accompanied by a squirting sound in the fuel oil pump.

d. Ignition test. (1) Purposes. (a) To check transformer strength.

(b) To discover leaks in ignition circuit.

(2) Method. (a) Open all three gate valves.

(b) Close fuel oil shut-off valve.

(c) Disconnect ignition leads at electrodes, keeping terminals separated and away from any ground.

(d) Check terminal posts for tightness.

(e) Check transformer porcelains for tightness.

(f) Test-run the generator so that the engine runs full speed, and, holding cables by insulation, bring terminals toward each other until the spark jumps.

(g) Separate terminals slowly, observing width

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of gap at instant spark disappears.

(h) Examine ignition cables for swellings, cracks, or worn places.

(i) Examine porcelains of electrodes for cracks and position.

(j) Be sure electrodes are at proper distance from any metal and properly spaced.

(k) Remove combustion head from burner and set it aside.

(l) Connect ignition leads to electrodes.

(m) Operate spark and observe intensity.

(n) Inspect engine generator for dirty commutator or defective leads.

(3) Signs. With the engine at full operating speed, the fact that the spark produced by the above steps cannot be drawn out at least 3/4-inch probably means that the generator is not functioning properly or that the transformer is weak.

e. Pressure regulating valve test. (1) Purposes. (a) To check the fuel oil shut-off valve.

(b) To determine the cause of erratic or other abnormal fuel oil pressure.

(2) Method. (a) Test-run the generator several times, observing whether the flame in the firebox goes out promptly when the engine is turned off.

(b) Check burner action with a commercial

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pressure gage during the test-run.

(c) Examine the fuel oil shut-off valve.

(3) Signs. (a) If the flame in the firebox does not go out promptly, the cause usually lies in the fuel oil shut-off valve. Possibly dirt or scale has lodged in the valve seat, preventing tight closing.

(b) A high irreducible pressure (as registered on the commercial gage used) usually indicates that the fuel oil relief valve is stuck in the closed position. Check this by disconnecting the fuel oil return line. If this does not relieve the pressure, the relief valve is obviously stuck in the closed position.

(c) A low pressure which cannot be increased, provided the fuel oil pump is not weak, indicates that the relief valve is stuck in the open position.

(d) Both irreducible high or irremedial low pressures also may be traceable to a broken and jammed spring in the pressure regulating valve.

33. POSSIBLE TROUBLES, CHECKS, CAUSES, AND CORRECTIONS. As a further guide to the operator of the mechanical smoke generator the following trouble outline is given. The outline is arranged in this manner: First, the trouble which may arise is described. Then various ways of discovering and remedying the cause of the trouble are suggested. Where the check to be made involves a service test the reader is referred by name to the appropriate test as described in paragraph 32.

a. Dial thermometer reads under 875 degrees Fahrenheit during the run. (1) Close the special oil hand-regulating valve completely.

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(2) Check the fuel oil pressure gage. It may be reading under 110. Try raising it by turning the adjusting stem of the pressure-regulating valve clockwise to increase the fuel oil burning rate and provide more heat.

(3) Atomizing nozzles may be clogged. Clean them.

(4) The fixed needle valve may be admitting too much special oil to the coil assembly. Close it a fraction of a turn.

(5) The water quick-opening valve may not be closed tightly. Adjust it.

b. Dial thermometer reads above 925 degrees Fahrenheit during run. (1) Open the special oil hand-regulating valve as far as it will go.

(2) The special oil pressure gage may read less than 50. If so, check the special oil gate valve, as it may be closed. The special oil suction line strainer may need cleaning. Tap the special oil relief valve with the handle of a screwdriver. This will sometimes dislodge dirt sticking under the poppet, which may cause binding of the moving parts of the valve. If tapping alone is inadequate, take the valve apart and clean it. At the same time remove and clean the special oil return line strainer.

(3) There may be air pockets in the special oil suction line. Air may be removed by opening the special oil petcock and test-running the generator until all entrapped air is dislodged and the special oil pressure gage builds up to 50. Hold a container under the petcock to collect oil that pours out.

(4) The special oil pump drive belt may need tightening.

(5) The fixed needle valve may be admitting too little oil to the coil assembly. Open it a fraction of a turn.

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(6) The special oil pump may be damaged. Replace it.

(7) In an emergency - and when no other method for keeping down the temperature can be found - close the fuel oil shut-off valve for a short time. This prevents fuel oil from entering the burner and eliminates the flame in the firebox. Barring fuel oil from the burner is not good for it and should be resorted to only when all other methods for keeping the temperature from rising too high have failed, or when stopping the generator for adjustments is tactically unfeasible.

c. Generator produces bad smoke. (1) If a fine mist of oil droplets appears it is probable that the dial thermometer is reading low or that the spray nozzle pressure gage is reading low. Remedy this by taking whatever steps are necessary to raise the dial thermometer reading.

(2) Black smoke - emerging from the furnace - may be caused by inadequate ignition of the fuel oil-air mixture by the burner electrodes. Check electrode points gap and adjust if necessary.

(3) Leaks in the coil assembly may cause fires instead of the proper smoke emission. To remedy this, install new coils.

(4) If bluish smoke appears while the generator is running in the "run" position it is probable that water orifice A is clogged. It is not necessary to shut down the generator. Disconnect the control lever linkage and open the water quick-opening valve above water orifice B.

(5) If irregularly angled jets of smoke appear at any of the spray nozzles this indicates that these spray nozzles are clogged and must be cleaned. If excessive clogging occurs the spray nozzle pressure gage will constantly read above 25 pounds,

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and the generator should be shut down for repairs at once.

(6) If excessive smoke appears during the warming up period, check the special oil pressure gage. If this gage is reading under 60 pounds, it is probable that the special oil quick-opening valve is not seating tightly and should be fixed.

d. The special oil pressure gage reads wrongly. (1) So long as the generator is producing good smoke and functioning correctly in all other respects, do nothing unless the reading is considerably off.

(2) The special oil suction line strainer may need cleaning.

(3) The special oil relief valve may be stuck in the open position. Tap it with the handle of a screwdriver. Clean if necessary.

(4) There may be air pockets in the special oil suction line. Rid the line of air as described in paragraph 33 b.

(5) The special oil pump belt may need tightening.

(6) The special oil pump may be damaged. Replace it.

(7) The special oil quick-opening valve may need tightening due to improper seating.

e. Spray nozzle pressure gage reads wrongly. (1) So long as the generator is producing good smoke and functioning correctly in all other respects, do nothing.

(2) Constant pressure above 20 pounds per square inch is probably due to plugged spray nozzles, plugged atomizing nozzles, or to the fact that too much water or too much

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special oil is entering the coil assembly.

(3) Constant pressure below 10 pounds per square inch after the run is well under way is probably due to a plugged water orifice, clogged water strainer, or to the fact that too little special oil is entering the coil assembly.

(4) Wide variations in pressure from below 10 pounds to above 20 pounds after the run is well under way may be due to the water quick-opening valve not being tightly closed.

(Note: New model generators do not carry a spray nozzle pressure gage.)

f. Burner starts but flame in firebox fails to appear, or is inadequate or fluctuating. (1) Fuel oil supply tank may need filling.

(2) Atomizing nozzles may need cleaning.

(3) Pressure regulating valve may be defective. Check with pressure regulating valve test.

(4) Fuel oil pump drive belt may need tightening.

(5) Fuel oil relief valve may be clogged.

(6) Air leaks in oil suction line. Rid the line of air as described in paragraph 33 b.

(7) Clogged strainers.

(8) Sludge in fuel oil system.

(9) Water in fuel oil, indicated by hissing noise in burner.

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(10) Defective atomizing nozzle, indicated by a bad-smelling fire or soot on the firebox walls.

(11) Fuel oil pressure low.

(12) Obstructions such as dirt, cement, scale, fallen brick, or sand in the burner air tube or in the firebox.

(13) Burner fan blades need cleaning.

g. Burner operates but fuel oil pressure is inadequate or nonexistent. (1) Fuel oil pump may not be rotating, indicating fuel oil pump drive belt needs tightening.

(2) Fuel oil gate valve may be closed.

(3) Air leaks in fuel oil suction line. Check with fuel oil pressure test.

(4) Fuel oil filter or strainer may need cleaning or replacement.

(5) Fuel oil line may be clogged at any point.

(6) Defective pump, calling for replacement.

h. Burner runs with proper oil pressure but no ignition.

(1) Film on commutator. Clean out film.

(2) Improper electrode setting.

(3) Improper atomizing nozzle position.

(4) Electrode porcelains may be cracked or shorted. Check with ignition test.

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(5) Ignition cables shorted or disconnected. Ignition test.

(6) Loose or corroded terminal posts. Ignition test.

(7) Loose transformer connections. Ignition test.

(8) Line voltage not correct, possibly too low, indicating defective engine generator.

(9) Transformer defective. Ignition test.

i. Burner runs with oil pressure and ignition but no flame. (1) Plugged atomizing nozzle.

(2) Fuel oil pressure too low.

(3) Water in fuel oil, indicated by hissing noise in the firebox.

(4) Atomizing nozzle spray one-sided, indicating improper setting of nozzle.

(5) Atomizing nozzle not tight in holder.

(6) Improper electrode setting.

(7) Wrong grade of fuel oil being used.

j. Too much fire in firebox. (1) Pressure regulating valve defectively set or clogged. Check with pressure regulating valve test.

(2) Fuel oil pressure too high.

k. Flame continues in firebox after burner shuts off.

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(1) Loose atomizing nozzle.

(2) Pressure regulating valve is not closing tightly. Check with pressure regulating valve test.

l. Odors, smoke, soot, or carbon in firebox. (1) Leaks in fuel oil outer discharge tubing where it enters burner.

(2) Spillage (i.e., fuel oil leak somewhere in system). Check all joints.

(3) Pressure regulating valve defective. Check with pressure regulating valve test.

(4) Fuel oil shut-off valve leaking.

(5) Fuel oil relief valve stuck.

(6) Atomizing nozzles badly set, defective, or clogged.

(7) Wrong grade of fuel oil being used.

m. Delayed ignition. (1) Improper electrode setting.

(2) Improper atomizing nozzle setting.

(3) Low voltage. Check engine generator.

(4) Transformer defective. Check with ignition test.

n. Fuel oil or special oil leaks. (1) Joints. Tighten, and if leak recurs, replace.

(2) Porous pipe or fittings, such as sand holes or cracks in line of fittings.

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(3) Test-run fuel and special oil pumps to see if either needs replacement.

(4) Pressure regulating valve may need tightening.

(5) Supply tanks defective. Replace if possible as it is hazardous to attempt repairs on a tank unless it can be steam-cleaned before being repaired.

(6) Atomizing nozzle loose.

o. Burner mixture ignites too slowly. (1) Loss of prime in fuel oil system. Check fuel oil pump.

(2) Air leaks in fuel oil suction line. See paragraph 33 b.

(3) Dirty or defective atomizing nozzle.

(4) Pressure regulating valve sticking.

(5) Electrodes incorrectly set or carbonized.

(6) Ignition cables shorted. Ignition test.

(7) Electrode porcelains cracked or leaking. Ignition test.

(8) Transformer defective or weak, terminals corroded or loose. Ignition test.

(9) Loose wiring connections.

(10) Defective engine generator.

p. White vapor appears in fire. (1) Close the fuel oil shut-off valve and check ignition system by means of ignition

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test.

(2) Make necessary correction in ignition system.

q. Water pump fails to deliver liquid. (1) Probably means pump is not primed.

(2) If after a minute's operation the pump delivers no water, stop the pump and prime it. Do this by pouring as much clean water as you think the pump can hold into the discharge side of the pump.

r. Water pump fails to deliver enough liquid. (1) Air leaks in water system line or through water pump packing gland. Replace or add glands.

(2) Water pump may be slow due to loose drive belt.

(3) Water pump may be badly worn or so damaged as to need replacement.

s. Water pump requires too much power. (1) Speed of pump is excessive due to over-tight drive belt.

(2) Liquid entering pump is heavier or more viscous than water.

(3) Water suction or discharge line obstructed.

(4) Pump drive shaft may be bent.

(5) Rotating element (spiral cams and shafts) on water pump binds.

(6) Packing gland caps too tight. Loosen.

t. Water pump hammers. (1) Air or gases in the liquid.

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(2) Water suction line leaks.

(3) Suction velocity too high.

u. Starter fails to operate. (1) Check all battery connections and cables from battery to starting motor, and from battery through the solenoid switch. Use ignition test.

(2) Check generator commutator and brushes. Replace brushes if they are noticeably worn.

(3) If brushes are not seating properly on the commutator they should be worn into the contour of the commutator by using a strip of No. 00 sandpaper between brush and commutator. The rough side should be toward the brush and should conform to the contour of the commutator.

(4) Inspect the commutator for roughness and burned bars. Burned bars are usually caused by loose coil leads. Clean the commutator with No. 00 sandpaper.

(5) Brush arms should be inspected. If the arms stick, brushes will not make proper contact with the commutator.

(6) Check brush spring tension. Weak tension will result in arcing, which burns the commutator and shortens the life of the brushes.

v. Discharged battery. (1) Loose or dirty terminals.

(2) Generator not charging, as indicated by ignition test.

(3) Cells need water.

w. Slow starter speed. (1) Battery needs recharging.

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(2) Loose or dirty battery terminals.

(3) Worn commutator brushes. Replace.

(4) Sticking commutator brushes. Free and check spring tension.

(5) Dirty or worn commutators. Clean.

34. HANDLING. For purposes of lifting and moving it, the mechanical smoke generator is equipped with four hooks (loops) attached to the frame as shown in figure 141. Block and tackle also are issued to all smoke generator companies. For purposes of lifting the generator - which must be done when it is removed from railroad cars or placed on vehicles - the company must provide itself with some sort of heavy scaffold such as that pictured in figure 142.

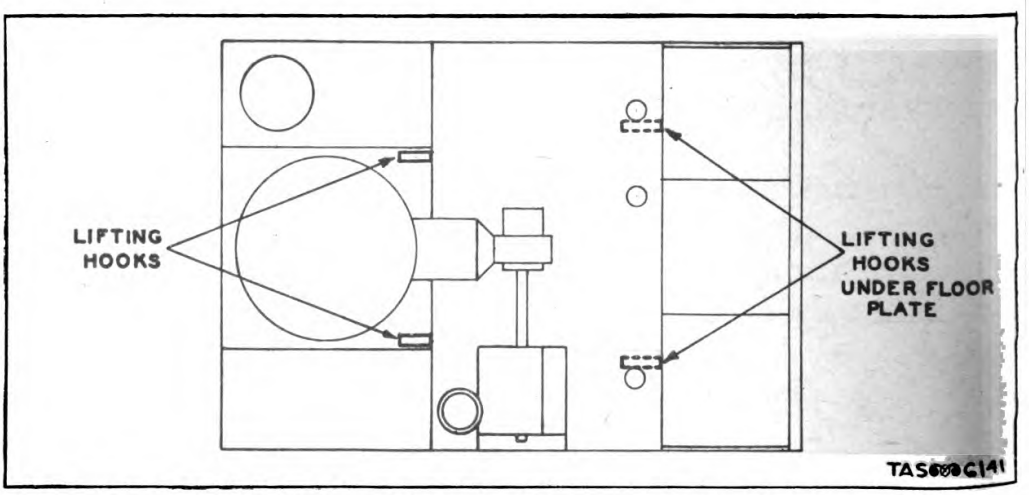

Fig. 141. Location of Generator Lifting Hooks (Loops).

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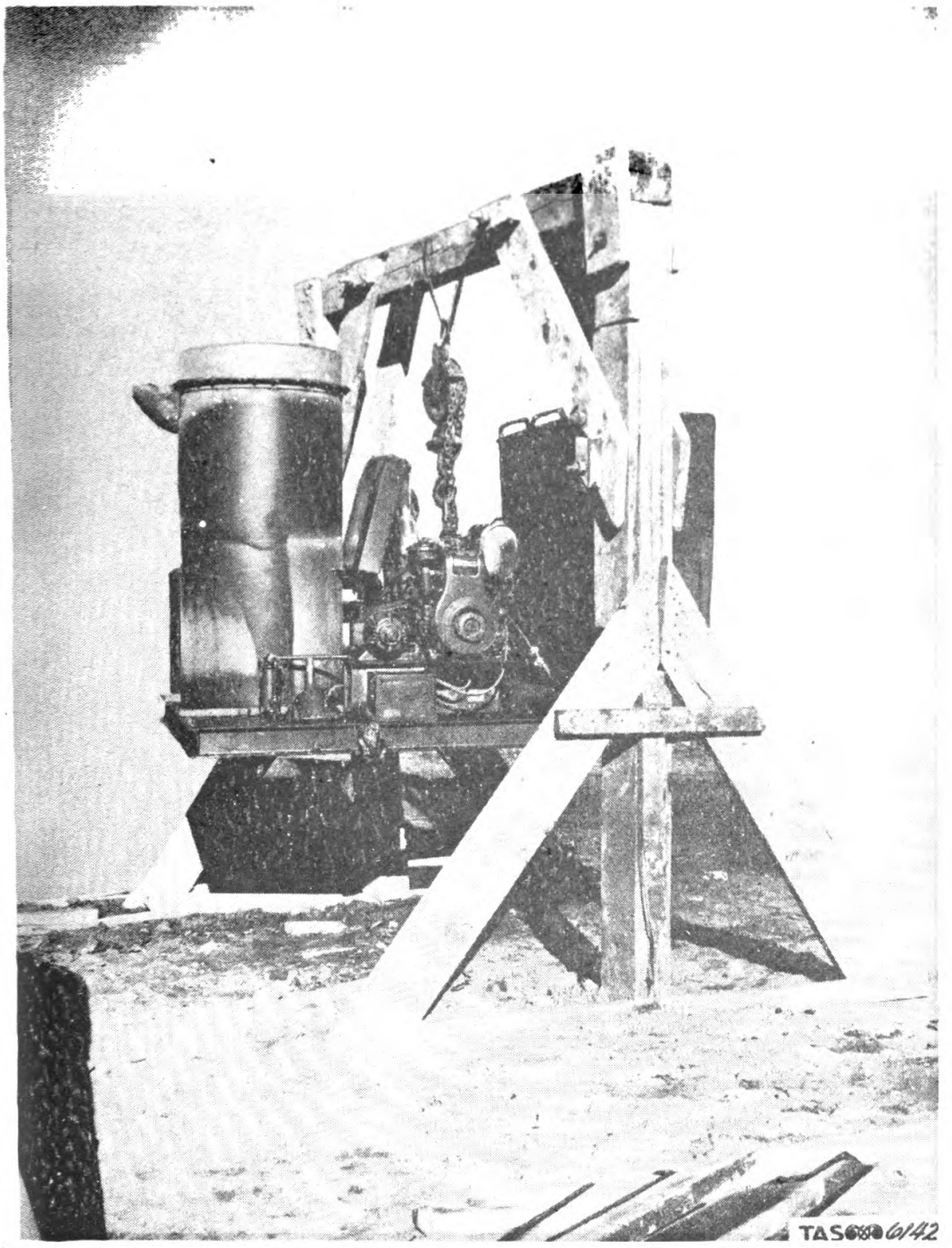

Fig. 142. Lifting Scaffold.

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SECTION VI

DESTRUCTION

Paragraph

Policy 35
Procedure 36

35. POLICY. When circumstances force the abandonment of smoke generators in the field they are destroyed to prevent their use by the enemy.

36. PROCEDURE. To render the machine ineffective as a smoke generator and to minimize the availability of its parts for other uses, take the following steps in the order listed:

a. Fill the fuel oil supply tank at least one-fourth full with fuel oil.

b. Remove the "catwhisker" on the dial thermometer in order to prevent the thermometer cut-off contact from functioning. To do this, remove the glass of the thermometer either by breaking it or by rotating it counter-clockwise, and snip off the "catwhisker" with a pair of pliers.

c. Break the special oil line at the special oil gate valve, and open the gate valve so that all special oil in the supply tank escapes to the ground. Then close the water gate valve. Pull out the thermometer well. If time does not permit breaking the special oil line, simply make certain that both the special oil and water gate valves are tightly closed. The object, in either case, is to prevent any special oil or water from flowing through the pumps and reaching the coil assembly. It is of course advantageous to permit the special oil to escape to obviate the possibility of its being used by the enemy.

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d. Open the fuel oil gate valve and make certain that the fuel oil shut-off valve is open so that fuel oil may reach the burner and that a flame will be produced in the firebox.

e. Place the control lever in the "run" position.

f. Turn on the ignition, start the gasoline engine, and run the generator. Running the generator with flame in the firebox but with no special oil or water running through the systems and with the thermometer cut-off contact rendered useless will accomplish the following:

(1) Destroy the water and special oil pumps.

(2) Cause the generator to overheat, a condition which quickly will mangle and distort the coil assembly to the point where the generator is rendered ineffective as a producer of smoke.

g. Permit the generator to overheat for a considerable period - at least until the coil assembly has been rendered useless. Then mangle and distort all valves, pipings, tanks, and other devices with a heavy instrument such as a sledge or axe. Smash engine parts, particularly the carburetor, the generator, the starting motor, and the magneto. Smash the air tube of the burner and mangle the combustion head assembly inside. Remove and throw away water orifices. Puncture supply tanks with machine gun bullets. It is difficult to destroy effectively the floor plates and frame, but if M14 incendiary grenades are available the application of these at various points will distort the plates and frame considerably. Weaker parts of the frame can, of course, be smashed.

h. Destruction of engine parts can be accomplished quickly by putting sand or emery in the crankcase, or draining the crankcase altogether and operating the engine at full speed.

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APPENDIX I

REFERENCES

Heil manual of Operation and Maintenance with Parts Catalog, October, 1942.

T/O	3-267	Chemical Smoke Generator Company.
T/E	3-267	Chemical Smoke Generator Company.
FM	3-5	Tactics of Chemical Warfare.
FM	3-15	Supply and Field Service.
FM	3-50	Air Defense Smoke and Smoke Generator Units. (When published.)
TM	1-455	Electrical Fundamentals.
TM	10-550	Fuels and Carburetion.
TM	10-570	The Internal Combustion Engine.
TM	10-590	Hand, Measuring, and Power Tools.

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APPENDIX II

FUEL SPECIFICATIONS

1. SPECIFICATIONS FOR SPECIAL OIL, CODED "SGF1".

Composition		(See note 1 below)
Viscosity SUS/210° F.		60 Max. (Note 2)
Conradson Carbon		0.1 Max.
Neut. No.		0.1 Max.
Pour Point		0° F. Max.
Distillation		(See note 1 below)
Vapor Temp. at 10 mm. Absolute Pressure.	10%	390° F. Min.
	50%	490° F. Min.
	90%	610° F. Max.

2. SPECIFICATIONS FOR COLD ZONE SPECIAL OIL, CODED "SGF2".

Composition	(Note 1)
Flash Point	320 Min.
Viscosity SUS/100° F.	100-110
Conradson Carbon	0.1 Max.
Neut. No.	0.1 Max.
Pour Point	Minus 40° F. Max.

3. GENERATOR FURNACE FUEL D (FUEL OIL).

Commercial Standard SS-12-40, #2 or #3 Grade, or U.S. Army No. 2-105-C.

Pour	0° F. Max.

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4. GENERATOR FURNACE FUEL E (KEROSENE).

Pour — Minus 40° F. Max.

5. WATER. Any water of low solids content and of potable quality is acceptable. Brackish or salt water must not be used. Denatured alcohol must be added to prevent freezing at prevailing lowest temperatures. (See Appendix III.)

6. DILUTION TABLE. The following table gives the dilutions necessary to insure pumpability at different temperature ranges. (See also Note 3 below.)

Temperature Range °F.		Oil Mix
60 - 100	100% SGF1	0% D
45 - 70	95% SGF1	5% D
35 - 60	90% SGF1	10% D
10 - 40	80% SGF1	20% D
0 - 40	75% SGF1	25% D
Minus 15 - Plus 40	100% SGF2	0% E
Minus 40 - 0	90% SGF2	10% E

Generator furnace fuel D may be used down to 0° F. Generator furnace fuel E may be used up to plus 40° F.

7. BLENDING PROCEDURES. a. Special oil and fuel oil will completely blend one with the other if they are thoroughly agitated together. In cool weather, when the special oil has thickened, this blending requires vigorous mixing. This is preferably done with a pump and a tank or other container equipped

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for circulating the oil from bottom to top of the tank at a high rate of flow until the oil is of uniform consistency.

b. Blending can be carried out in a barrel. Place in the barrel the correct proportions, filling it only three-fourths full. Up-end and roll the barrel many times until uniform consistency is obtained.

c. When adding oils to a tank or barrel for blending, it is best to add the fuel oil first, then the special oil on top. This is because the fuel oil, being the lighter of the two, will tend to rise up into the special oil.

Note 1. Special oil must be an all-distillate product from petroleum source; must contain no additives.

Note 2. 65 viscosity at 210° F. maximum for oils have 50 viscosity index or higher.

Note 3. Pumpability or viscosity can be changed by dilution but the pour point cannot. The wax which will crystallize out at the pour point will clog the machine.

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APPENDIX III

WATER-ALCOHOL MIXTURES

Percentage by Volume of Denatured Alcohol	Freezing Point of the Water-Alcohol Mixture
15	20° F.
25	10° F.
35	0° F.
40	Minus 10° F.
45	" 20° F.
55	" 30° F.
60	" 40° F.

Note: A slightly greater percentage of alcohol must be used to prevent freezing at the given temperatures.

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APPENDIX IV

REDUCED CAPACITY OPERATION

1. GENERAL. Some models of the mechanical smoke generator, M1, are equipped with reduced capacity jump-overs from the fuel-oil line to the special oil line at the manifold. The purpose of these jump-overs (or by-passes) is to reduce the consumption of fuel oil by the generator. Smoke generators equipped with no attachments for reduced capacity operation may be converted as follows:

a. Water by-pass. (See fig. 1.) Choose the horizontal 1/2-inch line carrying the quick-opening valve and the water manifold. Remove the elbows at each end of the line and replace them with 1/2-inch tees. Screw 1/2 x 1/4-inch bushings into the open connections of these two tees. Screw a 1/4-inch angle valve into one of these bushings, using the 1/4-inch close nipple

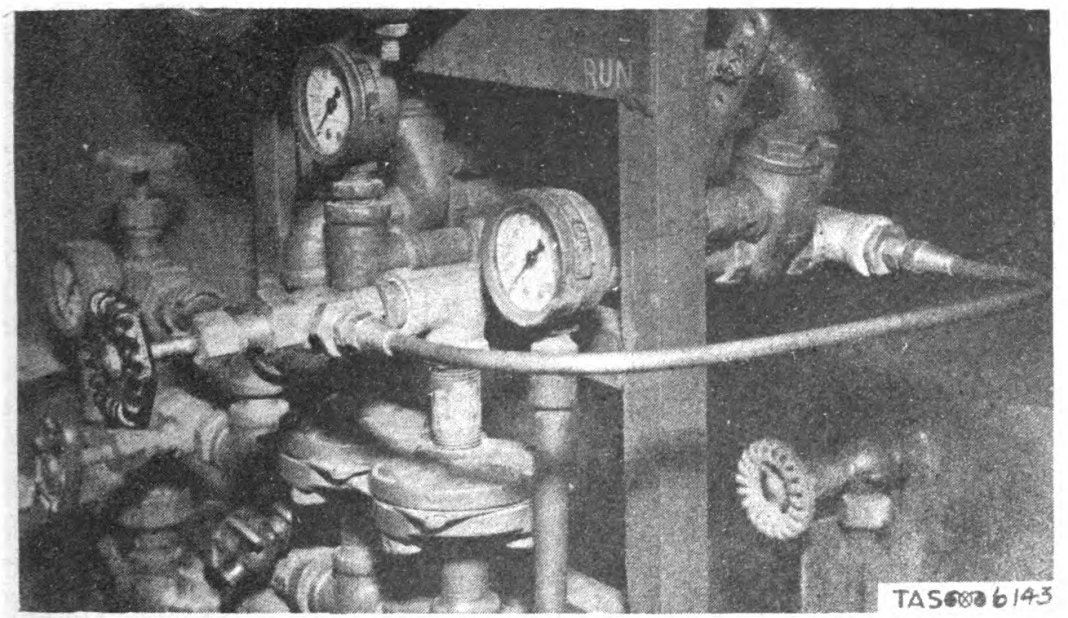

Fig. 1. Water By-pass.

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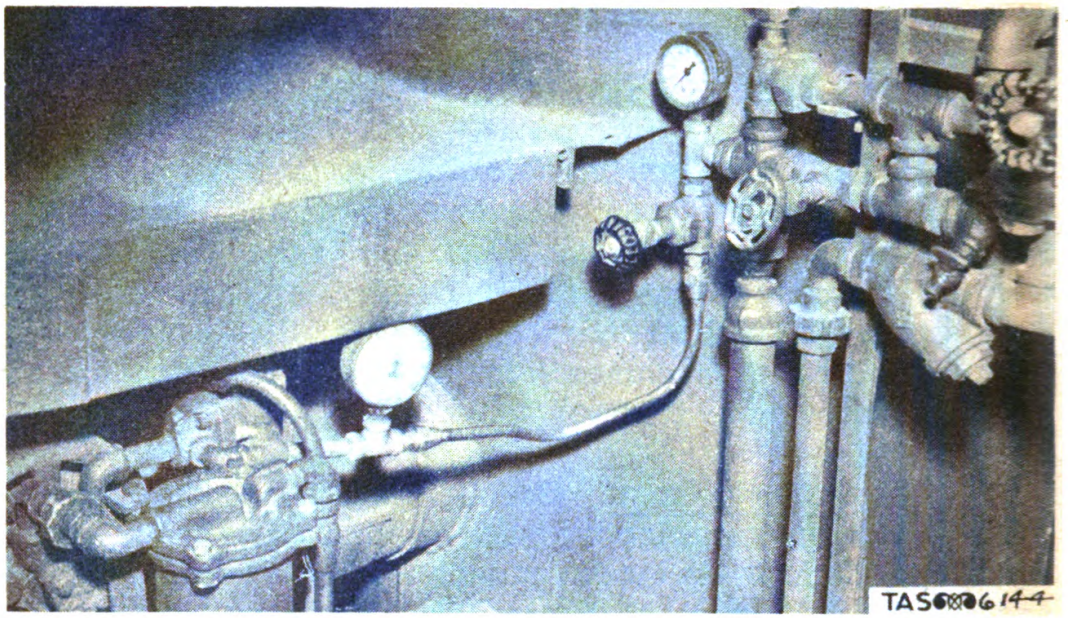

Fig. 2. Fuel Oil Jump-over.

provided. Screw a 1/4 x 1/4-inch connector into the angle valve and another connector into the bushing at the other tee. Install a length of 1/4-inch copper tubing between the two connectors.

b. Fuel oil jump-over. (See fig. 2.) Remove the pressure gage at the oil burner pressure regulating valve and screw a 1/4 x 3-inch nipple into the elbows from which the gage was removed. Screw a 1/4-inch tee onto the end of this nipple. Screw the pressure gage into one arm of the tee and into the other arm of the tee screw a 1/4 x 3/8-inch tubing connector. Remove the pressure gage and street elbow from the cross in the 1-inch special oil line at the oil manifold. Screw a close nipple and 1/4-inch tee into this connection. Into one arm of this tee screw the pressure gage. Into the other arm of the tee screw a close nipple and a 1/4-inch globe valve. Into the globe valve screw a 1/4 x 3/8-inch tubing connector. Connect the two tubing connectors with a length of 3/8-inch copper tube.

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2. LIST OF MATERIALS NEEDED TO CONVERT UNITS TO REDUCED CAPACITY OPERATION.

a. For water by-pass.

2 - 1/2" tees.
2 - 1/2" x 1/4" bushings.
2 - 1/4" pipe x 1/4" tubing connectors.
1 - 1/4" close nipple.
1 - 1/4" angle globe valve.
1 - pc. 1/4" copper tubing, 20" long.
1 - 1/2" close nipple.
2 - union nuts, brass for 1/4" tubing.

b. For fuel oil jump-over.

2 - 1/4" tees.
1 - 1/4" x 3" nipple.
2 - 1/4" close nipples.
1 - 1/4" brass globe valve.
2 - 1/4" pipe x 3/8" tubing connectors.*
1 - pc. 3/8" copper tubing, 18" long.
2 - union nuts, brass for 1/4" tubing.

(*Tubing to be flared into female part of connectors before shipment.)

3. OPERATION PROCEDURES. a. At 55 to 60 gallons per hour of oil (1) Start the unit up in the usual way at full capacity.

(2) After smoke is being generated, reduce the fuel oil burner pressure to 70 pounds per square inch by adjustment of pressure regulating valve on burner. (The latter will reduce the amount of fuel burned.)

(3) Open the valve in the by-pass line around the

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quick-opening water valve. This will double the amount of water feed to the furnace.

(4) Control the spray nozzle temperature to the normal 875-925 degrees Fahrenheit by adjustment of the special oil hand-regulating valve in the usual way.

(5) Before shutting down, close water by-pass valve and restore oil burner pressure to normal full capacity level. (See Note.)

b. At only 35 gallons per hour of oil. (1) Follow steps 1, 2, and 3 above.

(2) Gradually open the valve in the line connecting the pump on the oil burner to the special oil manifold, making sure that the valve is not opened so much as to reduce fuel oil burner pressure below 70 pounds per square inch.

(3) Control the spray nozzle temperature by adjustment of the special oil hand-regulating valve in the usual way.

(4) Before shutting down, close valve in line connecting fuel oil burner to special oil manifold, close water by-pass valve and restore oil burner pressure to normal full capacity level. (See Note.)

> Note: In order to facilitate starting the unit the next time, it may be found desirable to re-establish normal full capacity operation by increasing the flow of special oil to 100 gallons per hour before shutting down.

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[A. G. 062.11 (4–30–43).]

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G. C. MARSHALL,
Chief of Staff.

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J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:
Bn 3 (2); IC 3 (*); IC 9 (10).

Interested units:
*IC 3—Smoke Generator Companies (30); Maintenance Companies (10); Depot Companies (2); Composite Companies (10).
IC 9—Medium Maintenance Companies; Heavy Maintenance Companies.
(For explanation of symbols see FM 21–6.)

U. S. GOVERNMENT PRINTING OFFICE : 1943

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